This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

BRANNER
GEOLOGICAL LIBRARY

STANFORD UNIVERSITY
LIBRARIES

5.50
3992

4a rev bobk
[illegible]

Joseph Buckley.

5.50
399.2

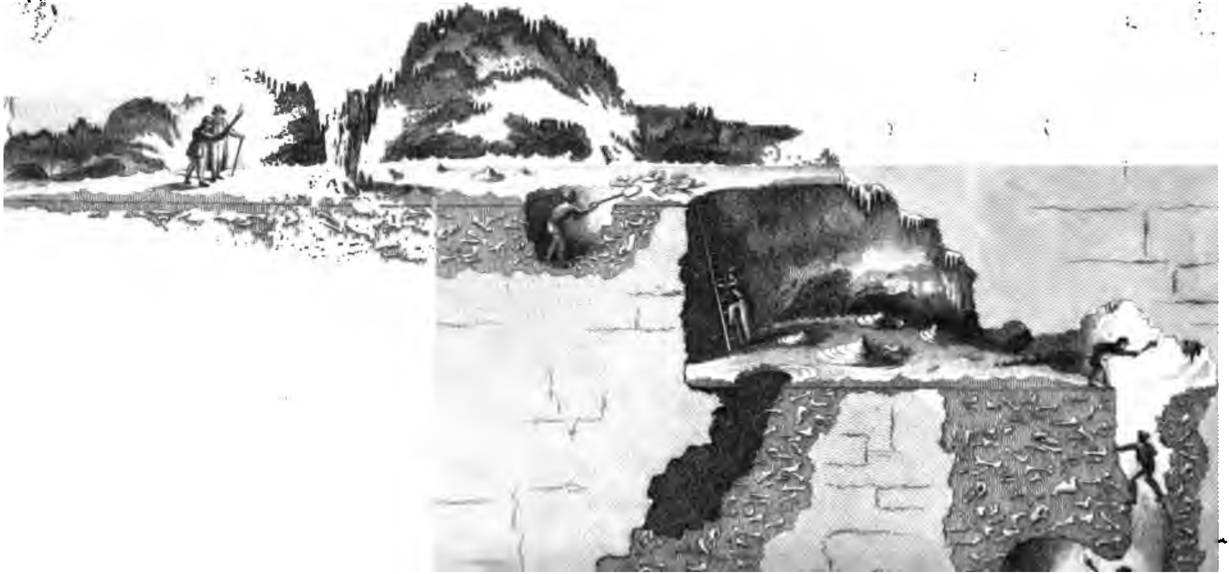
4a rev bobk
[illegible]

Joseph Buckley.

ESSAY

ON THE

THEORY OF THE EARTH.



ESSAY

ON THE

THEORY OF THE EARTH.

By BARON G. CUVIER,

PERPETUAL SECRETARY OF THE FRENCH INSTITUTE, PROFESSOR AND
ADMINISTRATOR OF THE MUSEUM OF NATURAL HISTORY,
&c. &c.

WITH

GEOLOGICAL ILLUSTRATIONS,

BY

PROFESSOR JAMESON.

FIFTH EDITION,
TRANSLATED FROM THE LAST FRENCH EDITION, WITH NUMEROUS
ADDITIONS BY THE AUTHOR AND TRANSLATOR.

WILLIAM BLACKWOOD, EDINBURGH; AND
T. CADELL, STRAND, LONDON.

MDCCCXXVII.

211365

Printed by P. Neill.

PREFACE

TO THE

FIFTH EDITION.

GEOLOGY, now deservedly one of the most popular and attractive of the physical sciences, was, not many years ago, held in little estimation; and even at present, there are not wanting some who do not hesitate to maintain, that it is a mere tissue of ill observed phenomena, and of hypotheses of boundless extravagance. The work of CUVIER now laid before the public, contains in itself not only a complete answer to these ignorant imputations, but also demonstrates the accuracy, extent, and importance of many of the facts and reasonings of this delightful branch of Natural History. Can it be maintained of a science, which requires for its successful prosecution an intimate acquaintance with Chemistry, Natural Philosophy and Astronomy,—with the details and views of Zoology, Botany, and Mineralogy, and which connects these different departments of knowledge in a most interesting and striking manner,—that it is of no value? Can it be maintained of Geology, which discloses to us the history of the first origin of organic beings, and traces their gradual developement from the monade to man himself,—which enumerates and describes the changes that plants, animals, and minerals—the atmosphere, and the waters of the globe—have undergone from the earliest geological periods up to our own time, and which even instructs us in the earliest history of the human species,—that it offers no gratification to the philosopher? Can even those who estimate the value of science, not by intellectual desires, but by practical advantages, deny the importance of Geology, certainly one of the foundations of agriculture, and which enables us to search out materials for numberless important economical purposes?

Geology took its rise in the Academy of Freyberg, with the illustrious WERNER, to whom we owe its present interesting condition. This being the case, we ought not, (as is at present too much the practice), amidst the numerous discoveries in the mineral kingdom which have been made since the system of investigation of that great interpreter of nature was made known, forget the master, and arrogate all to ourselves. In this Island, Geology first took firm root in the north: in Edinburgh the Wernerian geognostical views and method of investigation, combined with the theory of HUTTON, the experiments and speculations of HALL, the illustrations of PLAYFAIR, and the labours of the Royal and Wernerian Natural History Societies, excited a spirit of inquiry which rapidly spread throughout the Empire; and now Great Britain presents to the scientific world a scene of geological acuteness, activity, and enterprise, not surpassed in any other country.

On the Continent the writings of CUVIER, distinguished equally by purity and beauty of style, and profound learning, have proved eminently useful in aiding the progress of Geology. In this country CUVIER was first made known as a geologist by the publication of the present essay, which, from its unexampled popularity, has made his name as familiar to us as that of the most distinguished of our own writers.

ROBERT JAMESON.

COLLEGE MUSEUM, EDINBURGH,
25th November 1826.

ADVERTISEMENT

TO

FOURTH EDITION.

THIS Fourth Edition of the celebrated Essay on the Theory of the Earth, contains, besides many additional facts and statements in regard to the Natural History of the Earth, also learned discussions by CUVIER, on the newness of the present continents, as confirmed by the history of nations; and on the proofs regarding the antiquity of nations alleged to be contained in their astronomical and other monuments.

ROBERT JAMESON.

COLLEGE MUSEUM, EDINBURGH,
2d April 1822.

These organic remains are the relics of a primeval world long since passed away, proclaiming with a loud voice the instability of earthly affairs, and impressing upon the minds of those who seriously consider them, sentiments of piety and feelings of devotion. If the antiquary digs from among the ruins of Herculaneum a piece of ancient money, a vase, or a statue, we rejoice with him, in finding the record of the manners and arts of an ancient people, placed before our eyes. If he finds an old record, illustrative of the history of his country, however limited in extent that country may be, we are grateful to him for the particle of knowledge he has added to our [illegible] among the ruins of the common country of the in- [illegible] the great sepulchre of animated beings des- [illegible] who can look upon it without sentiments [illegible] the statues of Polycletus that we admire, [illegible] monuments of the workmanship of Nature, taken [illegible] great Herculeum overwhelmed by the ocean, [illegible] with feelings of the deepest wonder and devotion.

Fossil organic remains are the relics of a primeval world long since gone past, proclaiming with a loud voice the instability of earthly affairs, and impressing upon the minds of those who seriously consider them, sentiments of piety and feelings of devotion. If the antiquary digs from among the ruins of Herculaneum a piece of ancient money, a vase, or a statue, we rejoice with him, in finding the mode of life, the manners and arts of an ancient people, placed before our eyes: If he finds an old record, illustrative of the history of his country, however limited in extent that country may be, we are grateful to him for the particle of knowledge he has added to our store; but if, among the ruins of the common country of the human race, we linger at the great sepulchre of animated beings destroyed by the hand of fate, who can look upon it without sentiments of piety! It is not here the statues of Polycletus that we admire, but the admirable monuments of the workmanship of Nature, taken from the ruins of the great Herculeum overwhelmed by the ocean, that we look upon with feelings of the deepest wonder and devotion.

PREFACE

TO THE

THIRD EDITION.

THE attention of naturalists was early directed to the investigation of the fossil organic remains so generally and abundantly distributed throughout the strata of which the crust of the Earth is composed. It is not, as some writers now imagine, entirely a modern study; for even so early as the time of Leibnitz, we find that philosopher drawing and describing fossil bones. After this period it continued to interest individuals, and engage the particular attention of societies and academies. The Royal Society of London, by the Memoirs of Sloane, Collinson, Lister, Derham, Baker, Grew, Hunter, Jacobs, Plott, Camper, and many others, afforded satisfactory proofs of the importance attached to this branch of Natural History by philosophers in England; and the Memoirs of M. Graydon, in the Transactions of the Royal Irish Academy, shew that it was not entirely neglected in Ireland. On the continent of Europe the natural history of petrifactions was also much studied, as appears from the Memoirs of Hollman, Beckman, and Blumenbach, in the Transactions of the Royal Society of Gottingen;—of Gmelin, Pallas, Herrmann, Chappe, in the Memoirs of the Imperial Academy of Sciences of Petersburg;—of Geoffroi, Buffon, Daubenton, Faujas St Fond, and others of the old French Academy of Sciences;—of Astruc and Riviere, of the Royal Academy of Sciences of Montpellier;—of Collini of the Academia Theodoro-Palatina, at Manheim, &c. But the geognostical relations of the rocks in which these organic remains are contained were but ill understood, until Werner pointed out the mode of investigating them. His interesting and important views were circulated from Freyberg, by the writings and conversations of his pupils, and have contributed materially to the advancement of this branch of Natural History in Germany, France, and also in Great Britain. Petrifactions are no longer viewed as objects of mere curiosity, as things isolated and unrelated to the rocks of which the crust of the Earth is composed; on the contrary, they are now considered as one of the most important features in the strata of all regions of the earth. By the regularity and determinate nature of their distribution, they afford characters which assist us in discriminating not only single beds, but also whole formations of rocks; and in this respect they are highly interesting to the geognostical inquirer. To the geologist this beautiful branch of Natural History opens up numerous and uncommonly curious views of nature in the mineral kingdom: it shews him the commencement of the formation of organic beings,—it points out the gradual succession in the formation of animals, from the almost primeval coral near the primitive strata, through all the wonderful variety of form and structure observed in shells, fishes, amphibious animals, and birds, to the perfect quadruped of the alluvial land; and it makes him acquainted with a geographical and physical distribution of organic beings in the strata of the globe, very different from what is observed to hold in the present state of the organic world. The zoologist views with wonder and amazement those hosts of fossil animals, sometimes so similar to the present living species, at other times so far removed from them in form and structure. He compares the fossil orders, genera and species, with those now inhabiting the earth's surface, or living in its waters, and discovers that there is a whole system of animals in a fossil state different from the present. Even the physiologist, in the various forms, connections, and relations of the parts of those animals, obtains new facts for his descriptions and reasonings. Such, then, being the nature of this branch of Natural History, it is not surprising that, when once understood, it should have many and zealous cultivators, and occupy the talents of men of learning and sagacity. In our time, Cuvier, the celebrated Professor of Natural History in Paris, has eminently distinguished himself by his numerous discoveries, accurate descriptions, and rational views, on this subject. His great work on Fossil Organic Remains, of which a new edition is now in progress, is the most splendid contribution to Natural History furnished by any individual of this age.

The Essay on the Theory of the Earth, now translated, is the introductory part of the great work of Cuvier. The subject of the *deluge* forms a principal object of this elegant discourse. After describing the principal results at which the theory of the earth, in his opinion, has arrived, he next mentions the various relations which connect the history of the fossil bones of land animals with these results; explains the principles on which is founded the art of ascertaining these bones, or, in other words, of discovering a genus, and of distinguishing a species, by a single fragment of bone: and gives a rapid sketch of the results to which his researches lead, of the new genera and species which these have been the means of discovering, and of the different formations in which they are contained. Some naturalists, as Lamarck, having maintained that the present existing races of quadrupeds are mere modifications or varieties of those ancient races which we now find in a fossil state, modifications which may have been produced by change of climate, and other local circumstances, and since brought to the present great difference, by the operation of similar causes during a long succession of ages,—Cuvier shews that the difference between the fossil species and those which now exist, is bounded by certain limits; that these limits are a great deal more extensive than those which now distinguish the varieties of the same species, and consequently, that the extinct species of quadrupeds are not varieties of the presently existing species. This very interesting discussion naturally leads our author to state the proofs of the recent population of the world; of the comparatively modern origin of its present surface; of the deluge, and the subsequent renewal of human society.

In order to render this Essay more complete and satisfactory, I have illustrated the whole with an extensive series of observations, and have arranged them in such a manner that they will be readily accessible, not only to the naturalist, but also to the general reader.

Since the publication of the former edition of this Essay, many curious discoveries have been made in regard to fossil organic remains:—some of these are included in the Illustrations at the end of the Essay, others want of room forces us to omit.

R. JAMESON.

College of Edinburgh,
19*th April* 1817.

CONTENTS.

Page

Preliminary Observations, - - - - - - - - - 1

Plan of the Essay, - - - - - - - - - - - - - 4

First Appearance of the Earth, - - - - - - - - 6

First Proofs of Revolutions on the Surface of the Globe, - 6

Proofs that such Revolutions have been numerous, - - 10

Proofs that these Revolutions have been sudden, - - - 14

Proofs of the Occurrence of Revolutions before the Existence of Living Beings, - - - - - - - - - 16

Examination of the Causes which act at present on the Surface of the Globe, - - - - - - - - - 23

Of Slips, or Falling Down of the Materials of Mountains, 25

Of Alluvial Formations, - - - - - - - - - - 26

Of the Formation of Downs, - - - - - - - - - 28

Of the Formation of Cliffs, or Steep Shores, - - - - 29

Depositions formed in Water, - - - - - - - - 30

Of Stalactites, - - - - - - - - - - - - - - 31

Of Lithophytes, - - - - - - - - - - - - - - 32

Of Incrustations, - - - - - - - - - - - - - 32

Of Volcanoes, - - - - - - - - - - - - - - 34

Constant Astronomical Causes, - - - - - - - - 36

Older Systems of Geologists, - - - - - - - - - 38

Page
More Recent Systems, 41
Diversities of all the Systems, 44
Causes of these Differences, 46
Nature and Condition of the Problem, 46
Progress of Mineral Geology, 49
Importance of Fossil Remains in Geology, 51
High importance of the Fossil Bones of Quadrupeds, 53
Small probability of discovering new Species of large Quadrupeds, 56
Inquiry respecting the Fabulous Animals of the Ancients, 69
Difficulty of determining the Fossil Bones of Quadrupeds, 82
Principle by which this determination is effected, 83
View of the general Results of these Researches, 94
Relations of the Species of Fossil Animals, with the Strata in which they are found, 95
Proofs that the extinct Species of Quadrupeds are not Varieties of the presently existing Species, 102
Proofs that there are no Fossil Human Bones, 114
Physical Proofs of the Newness of the present Continents, 121
Additions of Land by the action of Rivers, 123
Progress of Downs, 133
Peat-mosses and Slips, 135
The History of Nations confirms the Newness of the Continents, 137
The very remote Antiquity attributed to certain Nations is not supported by History, 149
The Astronomical Monuments left by the Ancients do not bear the excessively remote Dates which have been attributed to them, 201

Page
Table of the Extent of the Zodaical Constellations, as they are designed upon our Globes, and of the Times required by the Colures to traverse them, - - - - - 212
Construction and Use of the Table, - - - - - - - - 216
The Zodiac is far from bearing in itself a certain and excessively remote date, - - - - - - - - - - - 230
Exaggerations relative to the Antiquity of certain Mining Operations, - - - - - - - - - - - - - - 238
General Conclusion relative to the Period of the last Revolution, - - - - - - - - - - - - - - - 239
Further Researches to be made in Geology, - - - - - 240
Recapitulation of the Observations upon the Succession of the Tertiary Formations, - - - - - - - - - - 243
Table of Geological Formations in the Order of their Superposition; by M. A. de Humboldt, - - - - - - 249
Enumeration of the Fossil Animals recognized by the Author, - - - - - - - - - - - - - - - - 253
Ichthyosaurus, - - - - - - - - - - - - - - 255
Plesiosaurus, - - - - - - - - - - - - - - 256
Crocodile, - - - - - - - - - - - - - - - 258
Megalosaurus, - - - - - - - - - - - - - - 259
Pterodactylus, - - - - - - - - - - - - - - 261
Iguanodon, - - - - - - - - - - - - - - - 263
Mosasaurus, - - - - - - - - - - - - - - - 264
Dolphin, - - - - - - - - - - - - - - - - ib.
Lamantin, - - - - - - - - - - - - - - - - 265
Morse, - - - - - - - - - - - - - - - - - 265
Palæotherium, - - - - - - - - - - - - - - 266
Lophiodon, - - - - - - - - - - - - - - - 268

Page
Anoplotherium, - - - - - - - - - - - - - 270
Anthracotheria, - - - - - - - - - - - - - 272
Cheropotamus, - - - - - - - - - - - - - - ib.
Adapis, - - - - - - - - - - - - - - - - 273
Vespertilio, - - - - - - - - - - - - - - - 274
Ziphius, - - - - - - - - - - - - - - - - 280
Mammoth, - - - - - - - - - - - - - - - 280
Mastodon, - - - - - - - - - - - - - - - 281
Hippopotamus, - - - - - - - - - - - - - - 283
Rhinoceros, - - - - - - - - - - - - - - - ib.
Elasmotherium, - - - - - - - - - - - - - 285
Horse, - - - - - - - - - - - - - - - - - 288
Fossil Elk, - - - - - - - - - - - - - - - 286
Megatherium, - - - - - - - - - - - - - - 289
Megalonyx, - - - - - - - - - - - - - - - 290
Bear, - - - - - - - - - - - - - - - - - - 291
Man, - - - - - - - - - - - - - - - - - - 294

APPENDIX.

On the Birds to which the name of Ibis was given by the Ancient Egyptians, - - - - - - - - - - - - - 299

GEOLOGICAL ILLUSTRATIONS

BY PROFESSOR JAMESON.

Page
On the Subsidence of Strata, - - - - - - - - - - 333
Deluge, - - - - - - - - - - - - - - - - - - 334
Formation of Primitive Mountains, - - - - - - - - 335
On the Distribution of Boulder-Stones in Scotland, Holland, Germany, Switzerland and America, - - - - 344
On the Alluvial Land of the Danish Islands in the Baltic and on the Coast of Sleswigh, - - - - - - - - - 354
On the Sand-Flood, - - - - - - - - - - - - - 368
Sand-Flood in Morayshire, - - - - - - - - - 369
Sand-Flood in the Hebrides, &c. - - - - - - - 372
Moving Sands of the African Deserts, - - - - 375
Action of the Sea upon Coasts, - - - - - - - - - 378
On the Growth of Coral Islands, - - - - - - - - - 379
On the Level of the Baltic, - - - - - - - - - - 398
Fossil Remains of the Human Species, - - - - - - 406
Account of the displacement of that part of the Coast of the Adriatic which is occupied by the Mouths of the Po, 410
On the Universal Deluge, - - - - - - - - - - - 417
On the action of Running Waters, - - - - - - - - 437
Connection of Geology with Agriculture and Planting, - 453
Account of the Fossil Elk of Ireland, - - - - - - - 486
Account of the Living Species of Elephant, and of the Extinct Species of Elephant or Mammoth, - - - - - 508
Account of the Caves in which Bones of Carnivorous Animals occur in great quantities, - - - - - - - - - 516
Cave containing Bones at Adelsberg, in Carniola, - - - 540
Tabular View of the Genera of Fossil Mammifera, Cetacea, Aves, Reptilia, and Insecta,—with their Geognostical Number and Distribution, - - - - - - - - - - - 547
Tabular View of the Classes, Orders, or Families of Animals, occurring in a Living or Fossil State, with their Geognostical Distribution, - - - - - - - - - - - - - 550

LIST OF PLATES.

The Frontispiece exhibits a vertical section of the Bone-Caves of Gaylenreuth, in Franconia.

Plate I. is a plan shewing the relative position of the Tertiary Mineral Formations around Paris.

II. is illustrative of the Succession of the Secondary Formations, and of the Distribution of Petrifactions.

II *a*. Extraordinary Fossil Animal named Pterodactylus longirostrus, found near Aichstedt, in Germany.

III. Figure of an Ibis in a Temple in Upper Egypt.

IV. Skeleton of an Ibis from a Mummy found at Thebes.

V. Numenius Ibis, supposed true Ibis of the Egyptians.

VI. Fossil Human Skeleton found in Guadaloupe.

VII. Cervus megaceros, Irish Elk in the Museum of the Royal Dublin Society.

VIII. Fig. 1. Head and Horn of the Fossil Irish Elk. It represents a larger view of the head, in which the different markings are delineated, and the expansion of the horns shewn in a front view. In this is also seen the peculiar forked appearance of the sur-antler.

Fig. 2. The portion of cast horn mentioned at p. 501, having the smooth convex surface at the root.

Fig. 3. An internal and external view of the perforated rib, described in p. 504.

IX. Cervus megaceros, Irish or Isle of Man Elk in the Royal Museum of the University of Edinburgh.

ESSAY

ON THE

THEORY OF THE EARTH.

PRELIMINARY OBSERVATIONS.

In my work on Fossil Bones, the object which I proposed was to discover to what animals the osseous remains, with which the superficial strata of the globe are filled, may have belonged. In pursuing this object, I had to follow a path in which but little progress had hitherto been made. As an antiquary of a new order, I was obliged at once to learn the art of restoring these monuments of past revolutions to their original forms, and to discover their nature and relations; I had to collect and bring together in their original order, the fragments of which they consisted; to reconstruct, as it were, the ancient beings to which these fragments belonged; to reproduce them with all their proportions and characters;

and, lastly, to compare them with those which now live at the surface of the globe:—an art almost unknown, and which presupposed a science whose first developments had scarcely yet been traced, that of the laws which regulate the coexistence of the forms of the different parts in organised beings. I had therefore to prepare myself for these inquiries, by others of a far more extensive kind, respecting the animals which still exist. Nothing, except an almost complete review of creation in its present state, could give a character of demonstration to the results of my investigation into its ancient state; but, from this review, I had at the same time to expect a great body of rules and affinities not less satisfactorily demonstrated; and it became obvious, that, in consequence of this essay upon a small portion of the theory of the earth, the whole animal kingdom would necessarily be in some measure subjected to new laws.

Thus I was encouraged in this twofold investigation, by the equal interest which it promised to possess, both with regard to the general science of anatomy, the essential basis of all those which treat of organised bodies, and with regard to the physical history of the globe, the foundation of mineralogy, geography, and even, it may be said, of the history of Man, and of all that it most concerns him to know with regard to himself.

If it be so interesting to us to follow, in the infancy of our species, the almost obliterated traces of extinct nations, why should it not also be so, to search, amid the darkness of the infancy of the Earth, for the traces of revolutions which have taken place anterior to the existence of all nations? We admire the power by which the human mind has measured the motions of the celestial bodies, which nature seemed to have concealed for ever from our view. Genius and science have burst the limits of space; and observations, explained by just reasoning, have unveiled the mechanism of the universe. Would it not also be glorious for man to burst the limits of time, and, by means of observations, to ascertain the history of this world, and the succession of events which preceded the birth of the human race? Astronomers have undoubtedly advanced more rapidly than naturalists; and the present period, with respect to the Theory of the Earth, bears some resemblance to that in which some philosophers fancied that the heavens were formed of polished stones, and that the moon was of the size of the Peleponnesus; but after ANAXAGORAS, came COPERNICUS and KEPLER, who pointed the way to NEWTON; and why should not natural history also one day have its Newton?

Plan of this Essay.

What I especially propose to present in this discourse, is the plan and the result of my labours regarding Fossil Bones. I shall also attempt to trace a rapid sketch of the efforts that have been made up to the present day, to restore the history of the revolutions of the globe. The facts which I have been enabled to discover, form, without doubt, only a small portion of those which would be necessary to complete this ancient history; but several of them lead to decisive consequences, and the rigorous manner in which I have proceeded in their determination, affords me reason to think that they will be regarded as points definitively fixed, and which in their aggregate will form an epoch in science. Lastly, I trust their novelty will be a sufficient excuse for me, if I claim for them the earnest attention of my readers.

My object will first be to shew by what relations the history of the fossil bones of terrestrial animals connects itself with the theory of the earth, and for what reasons a peculiar importance is to be attributed to it, with reference to this subject. I shall then unfold the principles upon which is founded the art of determining these bones, or, in other words, of recognizing a genus, and of distinguishing a species, by a single fragment of bone,—an art, on the certainty of which depends that of my whole work. I shall give a rapid account of the new species, and of genera previously unknown, which the application of these principles has led me to discover, as well as the different kinds of deposits in which they are contained. And as the difference between these species and those which exist at the present day is bounded by certain limits, I shall show that these limits much exceed those which now distinguish the varieties of the same species. I shall therefore make known to what extent these varieties may go, whether from the influence of time, or from that of climate, or, lastly, from that of domestication.

In this way I shall be enabled to conclude, and to induce my readers to conclude with me, that great events were necessary to produce the more considerable differences which I have discovered. I shall next mention the particular modifications which my researches must necessarily introduce into the hitherto received opinions regarding the revolutions of the globe; and, lastly, I shall inquire how far the civil and religious history of different nations corresponds with the results of observation with regard to the physical history of the Earth, and with the probabilities which these observations afford concerning the period at which societies of men may have found fixed places of abode, and fields susceptible of cultivation, and at which, therefore, they may have assumed a durable form.

First Appearance of the Earth.

When the traveller passes over those fertile plains where gently flowing streams nourish in their course an abundant vegetation, and where the soil, inhabited by a numerous population, adorned with flourishing villages, opulent cities, and superb monuments, is never disturbed, except by the ravages of war, or by the oppression of the powerful, he is not led to suspect that Nature also has had her intestine wars, and that the surface of the globe has been broken up by revolutions and catastrophes. But his ideas change as soon as he digs into that soil which now presents so peaceful an aspect, or ascends to the hills which border the plain; his ideas are expanded, if I may use the expression, in proportion to the expansion of the view, and begin to embrace the full extent and grandeur of those ancient events, when he climbs the more elevated chains, whose base is skirted by these hills, or when, by following the beds of the torrents which descend from those chains, he penetrates, as it were, into their interior.

First proofs of Revolutions on the surface of the Globe.

The lowest and most level parts of the earth, exhibit nothing, even when penetrated to a very great depth, but horizontal strata composed of substances more or less varied, and containing almost all of them innumerable marine productions. Similar strata, with the same kind of productions, compose the lesser hills to a considerable height. Sometimes the shells are so numerous as to constitute of themselves the entire mass of the rock; they rise to elevations superior to the level of every part of the ocean, and are found in places where no sea could have carried them at the present day, under any circumstances; they are not only enveloped in loose sand, but are often inclosed in the hardest rocks. Every part of the earth, every hemisphere, every continent, every island of any extent, exhibits the same phenomenon.

The times are past when ignorance could maintain, that these remains of organized bodies are mere sportings of nature, productions generated in the womb of the Earth, by its own creative powers; and the efforts made by some metaphysicians of the present day, will not probably succeed in bringing these exploded opinions again into repute. A scrupulous comparison of the forms of these remains, of their texture, and often even of their chemical composition, does not disclose the slightest difference between the fossil shells and those which still inhabit the sea: the preservation of the former is not less perfect than that of the latter; most commonly we neither observe detrition nor fracture in them, nothing, in short, that announces a violent removal from their original places; the smallest of them retain their sharpest ridges, and their most delicate spines. They have, therefore, not only lived in the sea, but they have also been deposited by it. It is the sea which has left them in the places where they are now found. But this sea has remained for a certain period in those places; it has covered them long enough, and with sufficient tranquillity to form those deposits, so regular, so thick, so extensive, and partly also so solid, which contain those remains of aquatic animals. The basin of the sea has therefore undergone one change at least, either in extent, or in situation. Such is the result of the very first search, and of the most superficial examination.

The traces of revolutions become still more apparent and decisive, when we ascend a little higher, and approach nearer to the foot of the great chains. There are still found many beds of shells; some of these are even thicker and more solid; the shells are quite as numerous, and as well preserved, but they are no longer of the same species. The strata which contain them are not so generally horizontal; they assume an oblique position, and are sometimes almost vertical. While in the plains and low hills it was necessary to dig deep, in order to discover the succession of the beds, we here discover it at once by their exposed edges, as we follow the valleys that have been produced by their disjunction. Great masses of debris form at the foot of the cliffs, rounded hills, the height of which is augmented by every thaw and tempest.

These inclined strata, which form the ridges of the secondary mountains, do not rest upon the horizontal strata of the hills which are situate at their base, and which form the first steps in approaching them; but, on the contrary, dip under them, while the hills in question rest upon their declivities. When we dig through the horizontal strata in the vicinity of mountains whose strata are inclined, we find these inclined strata re-appearing below; and even sometimes, when the inclined strata are not too elevated, their summit is crowned by horizontal ones *. The inclined strata are therefore older than the horizontal strata; and as they must necessarily, at least the greater number of them, have been formed in a horizontal position, it is evident that they have been raised †, and that this change in their direction has been effected before the others were superimposed upon them ‡.

---

* See Note A, at the end of this Essay.

† See Note B.

‡ The opinion maintained by some geologists, that certain strata have been formed in the inclined position in which

Thus the sea, previous to the deposition of the horizontal strata, had formed others, which, by the operation of problematical causes, were broken, raised, and overturned in a thousand ways; and, as several of those inclined strata which it had formed at more remote periods, rise higher than the horizontal strata which have succeeded them, and which surround them, the causes by which the inclination of these beds was effected, had also made them project above the level of the sea, and formed islands of them, or at least shoals and inequalities; and this must have happened, whether they had been raised by one extremity, or whether the depression of the opposite extremity had made the waters subside. This is the second result, not less clear, nor less satisfactorily demonstrated, than the first, to every one who will take the trouble of examining the monuments on which it is established.

Proofs that such revolutions have been numerous.

But it is not to this subversion of the ancient

---

they are now found, admitting it true with regard to some particular strata which might have been crystallized, as Mr Greenough supposes, like the deposit which encrusts the inside of vessels, in which water containing gypsum has been boiled, cannot at least apply to those which contain shells or rolled stones, which could not have waited, so suspended, the formation of the cement by which they were to be agglutinated.

strata, nor to this retreat of the sea after the formation of the new strata, that the revolutions and changes which have given rise to the present state of the Earth are limited.

When we institute a more detailed comparison between the various strata and those remains of animals which they contain, we presently perceive, that this ancient sea has not always deposited mineral substances of the same kind, nor remains of animals of the same species; and that each of its deposits has not extended over the whole surface which it covered. There has existed a succession of variations; the former of which alone have been more or less general, while the others appear to have been much less so. The older the strata are, the more uniform is each of them over a great extent; the newer they are, the more limited are they, and the more subject to vary at small distances. Thus the displacements of the strata were accompanied and followed by changes in the nature of the fluid, and of the matters which it held in solution; and when certain strata, by making their appearance above the waters, had divided the surface of the seas by islands and projecting ridges, different changes might take place in particular basins.

Amidst these variations in the nature of the general fluid, it is evident, that the animals which lived in it could not remain the same. Their

The changes in the level of the waters have not, therefore, consisted solely in a more or less gradual, or more or less general retreat; there have been various successive irruptions and retreats, the final result of which, however, has been a universal depression of the level of the sea.

Proofs that these Revolutions have been sudden.

It is of much importance to remark, that these repeated irruptions and retreats of the sea have neither all been slow nor gradual; on the contrary, most of the catastrophes which have occasioned them have been sudden; and this is especially easy to be proved, with regard to the last of these catastrophes, that which, by a twofold motion, has inundated, and afterwards laid dry, our present continents, or at least a part of the land which forms them at the present day. In the northern regions, it has left the carcases of large quadrupeds which became enveloped in the ice, and have thus been preserved even to our own times, with their skin, their hair, and their flesh. If they had not been frozen as soon as killed, they would have been decomposed by putrefaction. And, on the other hand, this eternal frost could not previously have occupied the places in which they have been seized by it, for they could not have lived in such a temperature. It was, therefore, at one and the same moment that these animals were destroyed, and the country which they inhabited became covered with ice. This event has been sudden, instantaneous, without any gradation; and what is so clearly demonstrated with respect to this last catastrophe, is not less so with reference to those which have preceded it. The breaking to pieces, the raising up and overturning of the older strata, leave no doubt upon the mind that they have been reduced to the state in which we now see them, by the action of sudden and violent causes; and even the force of the motions excited in the mass of waters, is still attested by the heaps of debris and rounded pebbles which are in many places interposed between the solid strata. Life, therefore, has often been disturbed on this earth by terrible events. Numberless living beings have been the victims of these catastrophes; some, which inhabited the dry land, have been swallowed up by inundations; others, which peopled the waters, have been laid dry, from the bottom of the sea having been suddenly raised; their very races have been extinguished for ever, and have left no other memorial of their existence than some fragments, which the naturalist can scarcely recognize.

Such are the conclusions to which we are necessarily led by the objects that we meet with at every step, and which we can always verify, by examples drawn from almost every country. These great and terrible events are every where distinctly recorded, so as to be always legible by the eye skilled to decypher their history in the monuments which they have left behind.

But what is still more astonishing and not less certain, *life* has not always existed upon the globe; and it is easy for the observer to distinguish the point at which it has begun to deposit its productions.

Proofs that there have been Revolutions anterior to the existence of living beings.

If we ascend to higher points of elevation, and advance towards the great ridges, the craggy summits of the mountain chains, we shall presently find those remains of marine animals, those innumerable shells, of which we have spoken, becoming more rare, and at length disappearing altogether. We arrive at strata of a different nature, which contain no vestiges of living beings. Nevertheless, their crystallization, and even their stratification, shew that they have been also in a liquid state at their formation; their inclined position, and the cliffs into which they are broken, shew that they also have been forcibly moved from their original places; the oblique manner in which they dip under the shelly strata, that they have been formed previously to these latter; and lastly, the height to which their rugged and bare peaks rise above all these shelly strata, that their summits had already emerged from the waters, when the shelly strata were forming.

Such are those celebrated Primitive Mountains which traverse our continents in different directions, raising themselves above the clouds, separating the basins of rivers from one another, affording, in their perennial snows, reservoirs which feed the springs, and forming, in some measure, the skeleton, and as it were the rough framework, of the Earth.

The eye perceives from afar, in the indentations with which their ridge has been marked, and in the sharp peaks with which it is bristled, indications of the violent manner in which they have been elevated. Their appearance, in this respect, is very different from that of those rounded mountains, and hills with long flat surfaces, whose less ancient masses have always remained in the situation in which they were quietly deposited by the waters of more recent seas.

These indications become more obvious as we approach. The valleys have no longer those gently-sloping sides, those salient and re-entering angles corresponding on either side to each other, which seem to denote the beds of ancient streams. They widen and they contract without any general rule; their waters, at one time, expand into lakes; at another, fall in torrents; and sometimes their rocks, suddenly approaching from each side, form transverse dikes, over which the waters tumble in cataracts. The dissevered strata, while they shew on one side their edges perpendicularly raised, on the other present large portions of their surface lying obliquely; they do not correspond in height, but those which, on one side, form the summit of the cliff, often dip underneath on the other, and are no longer visible.

Yet, amidst all this confusion, distinguished naturalists have been able to demonstrate, that there still reigns a certain order, and that those immense deposits, broken and overturned though they be, observe a regular succession with regard to each other, which is nearly the same in all the great mountain chains. According to them, Granite, of which the central ridges of the greater number of these chains consist, and which thus surmounts every other rock, is also the rock which is found deepest in the solid crust of the globe. It is the most ancient of those which we have found means of examining in the place assigned them by nature; and we inquire not at present, whether it owes its origin to a general fluid, which formerly held every thing in solution, or may have been the first consolidated by the cooling of a great mass in fusion, or even in a state of vapour [*].

---

[*] The conjecture of the Marquis de la Place, that the

Foliated rocks rest upon its sides, and form the lateral ridges of these great chains; schists, porphyries, sandstones, and talcose rocks, intermingle with their strata; lastly, granular marbles, and other limestones destitute of shells, resting upon the schists, form the outer ridges, the lower steps as it were, the counterforts, of these chains, and are the last formations, by which this unknown fluid, this sea without inhabitants, would seem to have prepared materials for the mollusca and zoophytes, which were presently to deposite upon these foundations vast heaps of their shells and corals.

We even find the first productions of these mollusca and zoophytes appearing in small numbers, and scattered at greater or less distances, in the last strata of these primitive formations, or in that portion of the crust of the globe to which geologists have given the name of Transition rocks. Here and there we meet with beds containing shells, interposed between certain granites of later

---

materials of which the globe is composed, have perhaps existed at first in the elastic form, and have successively assumed a liquid consistence on cooling, and have at length been solidified, is well supported by the recent experiments of M. Mitscherlich, who has composed, of all sorts of substances, and crystallized by the heat of intense furnaces, several of the mineral species which enter into the composition of primitive mountains.—Note D.

formation than the others, between schists of various kinds, and between some newer beds of granular marbles. Life, which was in the end to obtain entire possession of the globe, seems, in these primordial times, to have struggled with the inert nature which formerly predominated; and it was not until a considerable time after, that it obtained the ascendancy over it, and acquired for itself the exclusive right of continuing and elevating the solid envelope of the Earth.

Hence, it is impossible to deny, that the masses which now constitute our highest mountains, have been originally in a liquid state; and that they have for a long time been covered by waters in which no living beings existed. Thus, it has not been only since the appearance of life that changes have been operated in the nature of the matters which have been deposited; for the masses formed previous to that event, have varied, as well as those which have been formed since. They have also experienced violent changes in their position, and a part of these changes must have taken place at the period when these masses existed by themselves, and were not covered over by the shelly masses. The proof of this lies in the overturnings, the disruptions, and the fissures, which are observable in their strata, as well as in those of more recent formations, and which are in the ancient strata even in greater number and better defined.

But these primitive masses have also undergone other revolutions since the formation of the secondary strata, and have, perhaps, given rise to, or at least have partaken of, some of those changes which these strata themselves have experienced. There are actually considerable portions of the primitive formations uncovered, although placed in lower situations than many of the secondary formations; and we cannot conceive how it should have so happened, unless the primitive strata in those places had forced themselves into view, after the secondary strata had been formed. In certain countries, we find numerous large blocks of primitive substances scattered over the surface of secondary formations, aud separated by deep valleys, or even by arms of the sea, from the peaks or ridges from which they must have been derived. We must necessarily conclude, therefore, either that these blocks have been ejected by eruptions, or that the valleys (which must have stopped their course) did not exist at the time of their being transported; or, lastly, that the motions of the waters by which they were transported, exceeded in violence any thing that we can imagine at the present day *.

---

* The Travels of Saussure and Deluc present a multitude of facts of this description. These geologists imagined,

Here, therefore, we have a collection of facts, a series of epochs, anterior to the present time, of

---

that they could only have been produced by enormous eruptions. De Buch and Escher have recently employed themselves upon this subject. The memoir of the latter, inserted in the Nouvelle Alpina of Steinmüller, vol. i. presents the general results in a remarkable manner. The following is a comprehensive view of them: Such of these blocks as are scattered over the low parts of Switzerland and Lombardy, come from the Alps, and have descended along their valleys. They occur every where, and of all sizes, up to 50,000 cubic feet, over the great extent of country which separates the Alps from the Jura mountains; and they rise upon the sides of the latter facing the Alps, to a height of 4000 feet above the level of the sea. They are found at the surface, or in the superficial layers of debris, but not in the strata of sandstone, molasse, or conglomerate, which fill up almost every where the interval in question. They are sometimes isolated, sometimes in heaps. The height of their situation is not connected with their magnitude; the smaller ones alone appear sometimes a little worn, but the large ones are not so at all. Those which belong to the basin of each river are found, upon examination, to be of the same nature as the mountains of the tops or sides of the high valleys in which the tributary streams of this river take their rise. They are already seen in these upper valleys, and are particularly accumulated at the places which are situated above some of the contractions of these valleys. They have passed over the lower hills, when their height has not been more than 4000 feet; and then they are seen upon the other side of the ridges, in the cantons between the Alps and Jura, and even upon the latter itself. It is opposite the mouths of the valleys of the Alps that they are seen in the which the successive steps may be perfectly ascertained, although the duration of their intervals cannot be defined with precision. They are so many fixed points, which serve to regulate and direct our inquiries respecting this ancient chronology.

Examination of the Causes which act at present on the surface of the Globe.

Let us now examine those changes which are taking place at the present day upon the globe, investigating the causes which still act in its surface, and endeavouring to determine the possible extent of their effects. This portion of the history of the Earth is so much the more important, that it has

---

greatest quantity, and at the greatest heights; those of the intervening spaces have not been carried so high. Among the chains of the Jura mountains, which are more remote from the Alps, they are only found in places which are opposite the openings of the nearer chains.

From these facts, the author draws the conclusion, that the transportation of these blocks has taken place at a period subsequent to the deposition of the sandstones and conglomerates, and has perhaps been occasioned by the last of the revolutions which the globe has experienced. He compares the transportation in question to that which still takes place from the agency of torrents; but the objections presented by the consideration of the great size of the blocks, and the deep valleys over which they must have passed, appear to us to militate greatly against this part of his hypothesis.—Note E.

long been considered possible to explain the more ancient revolutions on its surface by means of these still existing causes; in the same manner as it is found easy to explain past events in political history, by an acquaintance with the passions and intrigues of the present day. But we shall presently see, that unfortunately the case is different in physical history:—the thread of operations is here broken; the march of Nature is changed; and none of the agents which she now employs, would have been sufficient for the production of her ancient works.

There still exist, however, four causes in full activity, which contribute to alter the surface of our continents. These are, rains and thaws, which waste down the steep mountains, and precipitate the fragments to their bottoms; running waters, which carry off these fragments, and deposit them in places where their current is abated; the sea, which undermines the foundations of elevated coasts, forming steep cliffs, and which throws up great banks of sand upon the low coasts; and, lastly, volcanoes, which pierce through the solid strata from below, elevate these strata, or spread over the surface vast quantities of ejected matter *.

---

* Regarding the changes of the surface of the earth, known from history or tradition, and consequently dependent on causes still in operation, see the German work of M. de Hof,

Of Slips, or Falling down of the Materials of Mountains.

In every place where the broken strata present their edges on abrupt surfaces, there fall down to their base, every spring, and even after every storm, fragments of their materials, which are rounded by rolling upon each other. These collected heaps gradually assume an inclination determined by the laws of cohesion, and thus form, at the bottom of the cliff, taluses, of greater or less elevation, according as the fragments which have fallen are more or less abundant. These taluses constitute the sides of the valleys in all elevated, mountainous regions, and are covered with a rich vegetation, whenever the fragments from the upper parts begin to fall less abundantly; but their want of solidity subjects themselves also to slips, when they are undermined by rivulets. On these occasions, towns, and rich and populous districts, are sometimes buried under the ruins of a mountain; the courses of rivers are interrupted, and lakes are formed in places which were before the abodes of fertility and cheerfulness. Fortunately these great slips happen but seldom, and

---

entitled "Geschechte der Natürliche Veränderungen der Erdoberfläche," 2 vols. 8vo. Goth. 1822 and 1824. The facts contained in it are collected with equal care and erudition.

the principal use of those hills of debris, is to furnish materials for the ravages of torrents.

Alluvial Formations *.

The rains which fall, the vapours which are condensed, and the snows which are melted, upon the ridges and summits of mountains, descend, by an infinite number of rills, along their slopes, carrying with them some portions of the materials of which these slopes are composed, and tracing slight furrows by their passage. These rills soon unite in the deeper gutters with which the surface is marked, run off by the deep valleys which intersect their bottom, and thus form streams and rivers, which carry back to the sea the waters it had formerly supplied to the atmosphere. On the melting of the snows, or when a storm takes place, these mountain torrents become suddenly swollen, and rush down the declivities with a velocity proportioned to their steepness. They dash violently against the bases of those taluses of fallen fragments which cover the sides of all the high valleys, carrying off the already rounded fragments of which they are composed, and which thus become smoothed, and still farther polished, by attrition. But in proportion as they reach the more level valleys, where their violence is diminished, or when they arrive at more expanded basins, where their waters are permitted to spread, they throw out upon their banks the largest of those stones which they had rolled down. The smaller fragments are deposited still lower; and nothing reaches the great canal of the river excepting the minutest particles, or the most impalpable mud. It often happens, also, that before these streams unite to form great rivers, they have to pass through large and deep lakes, in which their mud is deposited, and from which their waters come forth limpid.

---

* Note F.

The lower rivers, and all the streams which descend from the less elevated mountains and hills, also produce effects, upon the districts through which they flow, more or less analogous to those of the torrents from the higher mountains. When these rivers are swollen by great rains, they attack the base of the earthy or sandy hills which they meet with in their course, and carry their fragments to be deposited upon the lower grounds, and which are thus, in some degree, raised by each succeeding inundation. Finally, when the rivers reach great lakes or the sea, and when that rapidity, which carried off and kept in suspension the particles of mud comes to cease entirely, these particles are deposited at the sides of their mouths, where they form low grounds, by which the shores are prolonged. And if these shores are such, that the sea also throws up sand upon them, and thus contributes to their increase; there are created, as it were, provinces, and even entire kingdoms, which usually become the most fertile, and speedily the richest, in the world, if their rulers permit human industry to exert itself in peace.

Formation of Downs.[*]

The effects which the sea produces, without the co-operation of rivers, are much less beneficial. When the coast is low, and the bottom sandy, the waves push the sand toward the shore, where, at every reflux of the tide, it becomes partially dried; and the wind, which almost always blows from the sea, drifts it upon the beach. Thus are formed those hillocks of sand, named Downs, which, if the industry of man does not fix them by suitable plants, move slowly, but invariably, toward the interior of the country, and overwhelm fields and dwellings, because the same wind that raises the sand of the beach upon the down, throws that of its summit in the opposite direction from the sea. When the nature of the sand, and that of the water which is raised with it, are such as to form a durable cement, the shells and bones, thrown upon the beach, become incrusted with it. Pieces of wood, trunks of trees, and plants growing near the sea, are enveloped in these aggregates; and thus are produced what might be denominated *indurated downs*, such as we see upon the coasts of New Holland, and of which a precise idea may be formed from the description given of them by Peron *.

---

[*] Note G.

Formation of Cliffs or Steep Shores.

On the other hand, when the coast is high, the sea, which is thus prevented from throwing up any thing, exercises a destructive action upon it. Its waves, by sapping the foundation, cause the superincumbent portion of the face of the cliff, thus deprived of support, to be incessantly falling down in fragments. These fragments are tumbled about by the billows, until the softer and more divided parts disappear. The harder portions, from being rolled in contrary directions, assume the form of boulders and pebbles; and these, at length, accumulate in sufficient quantity to form a rampart, by which the bottom of the cliff is protected against farther depredations.

Such is the action of water upon the solid land; and we see, that it consists almost entirely in reducing it to lower levels, but not indefinitely.

---

* Voyage aux Terres Australes, t. i. p. 161.

The fragments of the great mountain ridges are carried down into the valleys; their finer particles, together with those of the lower hills and plains, are borne to the sea; alluvial depositions extend the coasts at the expence of the high grounds. These are limited effects, to which vegetation in general puts a stop, and which, besides, presuppose the existence of mountains, valleys, and plains, in short, all the inequalities of the globe; and which, therefore, cannot have given rise to these inequalities. The formation of downs is a phenomenon still more limited, both in regard to height and horizontal extent; and has no relation whatever to that of those enormous masses into the origin of which it is the object of geology to inquire.*

Depositions formed in Water.

Although we cannot obtain a precise knowledge of the action exerted by water within its own bosom, it is yet possible to determine its limits to a certain degree.

Lakes, pools, marshes, and sea-ports, into which rivulets discharge their waters, more especially when these descend from near and steep hills, deposit large quantities of mud, which would at length fill them up entirely, if care were not taken to clean them out. The sea also throws quantities of slime and sediment into harbours and creeks; into all places, in short, where its waters are more tranquil than ordinary. The currents also heap up at their meeting, or throw out at their sides, the sand which they are continually raising from the bottom of the sea, forming it into banks and shallows.

---

* Note H.

Stalactites.

Certain waters, after dissolving calcareous substances by means of the superabundant carbonic acid with which they are impregnated, allow these substances to crystallize after the acid has evaporated; and, in this manner, form stalactites, and other concretions. There are strata, confusedly crystallized in fresh water, which are sufficiently extensive to be compared with some of those which have been deposited by the ancient sea. The famous Travertine quarries of the neighbourhood of Rome, and the rocks of the same substance, which are formed, and continually varied in figure, by the river of Teverona, are generally known. These two modes of action may be combined; the deposits accumulated by the sea may be solidified by stalactite. Thus, when springs abounding in calcareous matter, or containing some other substance in solution, happen to fall into places where these deposits are formed, we then find aggregates in which marine and fresh-water productions may be blended. Of this description are the banks in the island of Guadeloupe, which, along with human skeletons, present land and sea shells mingled together. Of the same nature also is the quarry described by Saussure, in the neighbourhood of Messina, in which the sandstone is seen forming by the consolidation of the sand thrown up by the sea.

Lithophytes.

In the torrid zone, where lithophytes of many species abound, and are propagated with great rapidity, their strong trunks are interwoven and accumulated so as to form rocks and reefs; and rising even to the surface of the water, shut up the entrance of harbours, and lay frightful snares for navigators. The sea, throwing up sand and mud upon the tops of these shoals, sometimes raises their surface above its own level, and forms islands, which are soon covered with a rich vegetation.

Incrustation.

It is also possible, that, in particular places, large quantities of the animals inhabiting shells, leave their stony coverings when they die, and that these, cemented together by slime of greater or less consistence, or by other cementing substances, form extensive deposits or shell banks. But we have no evidence that the sea can now incrust those shells with a paste as compact as that of the marbles, the sandstones, or even the coarse limestone (calcaire grossier) in which we see the shells of our strata enveloped. Still less do we any where find the sea depositing those more solid and more siliceous strata which have preceded the formation of the shelly strata.

In short, all these causes united, would not change, in an appreciable degree, the level of the sea; nor raise a single stratum above its surface; and still less would they produce the smallest hillock upon the surface of the earth.

It has been asserted that the sea has undergone a general diminution of level; and proofs of this are said to have been discovered in some parts of the shores of the Baltic.* But whatever may be the causes of these appearances, we are certain that they are not general in their operation; and that, in the greater number of harbours, where any alteration of the level would be a matter of so much interest, and where fixed and ancient works afford so many means of measuring its variations, the mean level of the sea is constant. There has, therefore, never been a universal lowering, nor a universal encroachment, of the waters of the ocean. In some places, indeed, such as Scotland, and various parts of the Mediterranean, evidence has been thought to have been found, that the sea has risen, and that it now covers shores which were formerly above its level *.

---

* It is a common opinion in Sweden, that the level of the sea is becoming lower, and that many places may even be forded or passed dry-shod, which were formerly impracticable. Eminent philosophers have adopted this popular opinion; and M. von Buch goes so far as to suppose that the whole of Sweden is gradually rising. But it is singular, that no one has made, or at least published, a series of accurate observations, calculated to confirm a fact that had been announced so long ago, and which would leave no doubt upon the mind, if, as Linnæus asserts, this difference of level were so much as four or five feet yearly. Note I.

Volcanoes.

The action of volcanoes is still more limited, and more local, than any of those which have yet been mentioned. Although we have no precise idea of the means by which nature keeps up these violent fires at such great depths, we can judge decidedly, by their effects, of the changes which they may have produced at the surface of the globe. After a volcano has announced itself, by some shocks of an earthquake, it forms for itself an opening. Stones and ashes are thrown to a great distance, and lava is vomited forth. The more fluid part of the lava flows in long streams, while the less fluid portion stops at the edges of the opening, raises its margins all round, and forms a cone, terminated by a crater. Thus volcanoes accumulate upon the surface matters which were previously buried in the bowels of the earth, after modifying their nature, and raise themselves into mountains. By these means, they have formerly covered some parts of our continent, and have also suddenly produced islands in the middle of the sea. But these mountains and islands have always been composed of lava, and all their materials have undergone the action of fire: they are disposed as matters should be, which have flowed from an elevated point. Volcanoes, therefore, neither raise nor overturn the strata through which their apertures pass; and if some causes acting from those depths have contributed, in certain cases, to raise up large mountains, they cannot have been volcanic agents of the same nature as those which exist at the present day.

---

* Mr Stevenson, in his observations upon the bed of the German Ocean and British Channel, maintains that the level of the sea is continually rising, and has been very sensibly elevated within the last three centuries. Fortis asserts the same of some parts of the Adriatic sea. But the example of the Temple of Serapis, near Pouzzola, proves that the margins of that sea are, in many places, of such a nature as to be subject to local risings and fallings. On the other hand, there are thousands of quays, roads, and other works, made along the sea-side by the Romans, from Alexandria to Belgium, the relative level of which has never varied. Note K.

Thus, we repeat, it is in vain that we search, among the powers which now act at the surface of the earth, for causes sufficient to produce the revolutions and catastrophes, the traces of which are exhibited by its crust: And if we have recourse to the constant external forces with which we are as yet acquainted, we shall have no greater success.

Constant Astronomical Causes.

The pole of the earth moves in a circle around the pole of the ecliptic, and its axis is more or less inclined to the plane of the ecliptic; but these two motions, the causes of which are now ascertained, are much too limited for the production of effects like those whose magnitude we have just been stating. At any rate, their excessive slowness would render them altogether inadequate to account for catastrophes which, as we have shewn, must have been sudden.

The same reasoning applies to all other slow motions which have been conceived as causes of the revolutions in question, chosen doubtless in the hope that their existence could not be denied, because it might always be easy to hold out that their very slowness rendered them imperceptible. But whether they be true or not is of little importance, for they explain nothing, as no cause acting slowly could have produced sudden effects.

Admitting that there has been a gradual diminution of the waters; that the sea has transported solid matters in all directions; that the temperature of the globe is either diminishing or increasing;—none of these causes could have overturned our strata; enveloped in ice large animals, with their flesh and skin; laid dry marine testacea, the shells of which are, at the present day, as well preserved as if they had been drawn up alive from the sea; and, lastly, destroyed numerous species, and even entire genera.

These considerations have struck most naturalists; and among those who have endeavoured to explain the present state of the globe, hardly any one has attributed it entirely to the agency of slow causes, still less to causes operating under our eyes. The necessity to which they are thus reduced, of seeking for causes different from those which we see acting at the present day, is the very circumstance that has forced them to make so many extraordinary suppositions, and to lose themselves in so many erroneous and contradictory speculations, that the very name of their science, as I have elsewhere remarked, has long been a subject of ridicule to prejudiced persons, who have only looked to the systems which it has been the means of hatching, and have forgotten the extensive and important series of authentic facts which it has brought to light*.

---

* When I formerly mentioned this circumstance of the science of geology having become ridiculous, I only expressed a fact, to the truth of which every day bears witness; but in

Older Systems of Geologists.

During a long time, two events or epochs only, the Creation and the Deluge, were admitted as comprehending the changes which have been operated upon the globe; and all the efforts of geologists were directed to account for the present existing state of things, by imagining a certain original state, afterwards modified by the deluge, of which also, as to its causes, its operations, and its effects, each entertained his own theory.

Thus, according to one *, the earth was at first invested with an uniform light crust, which covered the abyss of the sea; and which being broken up for the production of the deluge, formed the mountains by its fragments. According to another †, the deluge was occasioned by a momentary suspension of cohesion among the particles of mineral bodies; the whole mass of the globe was dissolved, and the paste thus formed became penetrated with shells. According to a third ‡, God raised

---

this I did not profess to give my own opinion, as some respectable geologists seem to have believed. If their mistake has arisen from any thing equivocal in my expressions, I here apologize to them.

* Burnet, Telluris Theoria Sacra. Lond. 1681.

† Woodward, Essay towards the Natural History of the Earth. Lond. 1702.

‡ Scheuchzer, Mém. de l'Acad. 1708.

up the mountains for the purpose of allowing the waters, which had produced the deluge, to run off; and selected those places in which there was the greatest quantity of rocks, without which the mountains could not have supported themselves. A fourth * created the earth from the atmosphere of one comet, and deluged it by the tail of another: The heat which it retained from its origin, was what, in his opinion, excited the whole of the living beings upon it to sin; for which they were all drowned, excepting the fishes, whose passions were apparently less vehement.

It is evident, that, even while confined within the limits prescribed by the Book of Genesis, naturalists might still have a pretty wide range: they soon found themselves, however, in too narrow bounds; and when they had succeeded in converting the six days of creation into so many indefinite periods, the lapse of ages no longer forming an obstacle to their views, their systems took a flight proportioned to the periods which they could then dispose of at pleasure.

Even the great Leibnitz amused himself, like Descartes, by conceiving the earth to be an extinguished sun†, a vitrified globe, upon which the vapours falling down again, after it had cooled,

---

* Whiston, New Theory of the Earth. Lond. 1708.

† Leibnitz, Protogæa. Act. Lips. 1683; Gott. 1749.

formed seas, which afterwards deposited the limestone formations.

By Demaillet the whole globe was conceived to have been covered with water for many thousands of years. He supposed this water had gradually retired; that all the land animals were originally inhabitants of the sea; that man himself commenced his career as a fish; and he asserts, that it is not uncommon, even now, to meet with fishes in the ocean, which are still only half converted into men, but whose descendants will in time become perfect human beings *.

The system of Buffon is merely an extension of that of Leibnitz, with the addition only of a comet, which, by a violent blow, struck off from the sun the liquefied mass of the earth, together with those of all the other planets at the same instant. From this supposition, he was enabled to assume positive dates, as, from the present temperature of the earth, it could be calculated how long it had taken to cool down so far; and, as all the other planets had come from the sun at the same time, it could also be calculated how many ages are still required for cooling the greater ones, and to what degree the smaller are already frozen†.

---

* Telliamed. Amsterd. 1748.

† Theorie de la Terre, 1749; and Epoques de la Nature, 1775.

More recent Systems.

In our own times, men of still bolder imaginations have exercised their minds upon this great subject. Some writers have revived and greatly extended the ideas of Demaillet. They suppose that every thing was originally fluid; that this fluid gave existence to animals, which were at first of the most simple kind, such as the monads and other infusory and microscopic species; that, in process of time, and by assuming different habits, the races of animals became complicated, and assumed that diversity of nature and character in which they now appear. By means of those various races of animals, part of the waters of the sea have gradually been converted into calcareous earth; while the vegetables, concerning the origin and metamorphoses of which these writers are totally silent, have, on their part, converted a portion of the same water into clay: These two earths, on being stripped of the characters which life had impressed upon them, are resolved, by a final analysis, into silex; and hence the reason that the oldest mountains are more siliceous than the rest. All the solid parts of the earth, therefore, owe their existence to life, and, without life, the globe would still be entirely liquid *.

---

* See La Physique de Rodig. p. 106, Leipsic, 1801; and

Other writers have preferred the ideas of Kepler, and, like that great astronomer, have considered the globe itself as possessed of vital faculties. According to them a vital fluid circulates in it; a process of assimilation goes on in it, as well as in animated bodies; every particle of it is alive; it possesses instinct and volition, even to the most elementary molecules, which attract and repel each other according to sympathies and antipathies. Each kind of mineral has the power of converting immense masses into its own nature, as we convert our food into flesh and blood. The mountains are the respiratory organs of the globe, and the schists its organs of secretion; it is by these latter that it decomposes the water of the sea, in order to produce the matters ejected by volcanoes. The veins are carious sores, abscesses of the mineral kingdom; and the metals are products of rottenness and disease, which is the reason that almost all of them have so bad a smell *.

Telliamed, vol. ii. p. 169, as well as a multitude of new German works. M. de Lamarck has of late years developed this system to a great extent, in France, and supported it with much ingenuity, in his Hydrogeologie and Philosophie Zoologique.

* M. Patrin has shewn much ingenuity in supporting these fantastical ideas, in several articles of the Nouveau Dictionnaire d'Histoire Naturelle.

More recently still, a philosophy, which substitutes metaphor for reasoning, and proceeds on the system of absolute identity or of pantheism, attributes the production of all phenomena, or which, in the eyes of its supporters, is the same thing, all beings, to polarization, such as is manifested by the two electricities; and denominating every kind of opposition or difference, whether of situation, of nature, or of function, by the title of Polarisation, opposes to each other, in the first place, God and the universe; then, in the universe, the sun and the planets; next, in each planet, the solid and the liquid; and, pursuing this course, changing its figures and allegories according to its necessities, at length arrives at the last details of organic species *.

It must, however, be observed, that these are what may be termed extreme examples, and that all geologists have not carried the extravagance of their conceptions to such a length as those which we have just cited. Yet, among those who have proceeded with more caution, and have not searched for geological causes beyond the limits of physical and chemical science, much diversity and contradiction still prevail.

---

* This application of pantheism to geology may be best seen in the works of Oken and Steffens.

Diversities of all the Systems.

According to one system, every thing has been successively precipitated by crystallization, and deposited nearly as it exists at present; but the sea, which covered all, has gradually retired [*].

According to another, the materials of which the mountains consist, are incessantly worn down and carried off by the rivers to be deposited at the bottom of the sea, where they are heated under an enormous pressure, and form strata, which are one day to be violently lifted up by the heat which consolidates them [†].

A third supposes the fluid divided into a multitude of lakes, placed, like the seats of an amphitheatre, above each other, which, after having deposited our shelly strata, have successively broken their dikes, to descend and fill the basin of the ocean [‡].

According to a fourth, tides of seven or eight hundred fathoms depth have carried off, from time to time, the matter lying at the bottom of the sea, and have thrown it, in the form of mountains and hills, upon the original valleys or plains of the continent *.

---

[*] Delamétherie, in his "Geólogie," admits crystallization as the principal agent.

[†] Hutton and Playfair.—Illustrations of the Huttonian Theory of the Earth. Edin. 1802.

[‡] Lamanon,—in various parts of the Journal de Physique,—after Michaelis, and several others.

A fifth makes the various fragments of which the earth is composed, fall successively from heaven, in the manner of meteoric stones, bearing the impress of their foreign origin in the unknown beings whose remains they contain †.

A sixth represents the globe as hollow, and places within it a loadstone nucleus, which is transported from one pole to the other, by the attraction of comets, carrying along with it the centre of gravity, and the mass of waters at the surface; thus alternately drowning the two hemispheres ‡.

We might mention twenty other systems, as different from one another as those enumerated. And to prevent mistake, we may here state, that our intention is not captiously to criticize or find fault with their authors; on the contrary, we admit that these ideas have generally been conceived by men of intellect and knowledge, who were not

---

* Dolomieu, in the Journal de Physique.

† MM. de Marschall, in their Researches respecting the Origin and Development of the present order of the World. Giessen, 1802.

‡ Bertrand,—Periodical Renewal of the Terrestrial Continents. Hamburgh, 1799.

ignorant of facts, several of whom had even travelled extensively for the purpose of examining them, and who, in this manner, made numerous and important additions to science.

Causes of these differences.

Whence comes it, then, that there should be so much contrariety in the solutions of the same problem, that are given by men who proceed upon the same principles? May not this have been occasioned by the conditions of the problem never having been all taken into consideration at once; by which it has remained hitherto indeterminate, and susceptible of many solutions,—all equally good, when such or such conditions are abstracted; and all equally bad, when a new condition comes to be known, or when the attention is directed to some condition which had been formerly neglected?

Nature and Conditions of the Problem.

To quit the language of mathematics, it may be asserted, that almost all the authors of these systems, confining their attention to certain difficulties which struck them more forcibly than others, have endeavoured to solve these in a manner more or less plausible, and have left unnoticed others, equally numerous, and equally important. For example, the only difficulty with one consisted in explaining the changes that had taken place in the level of the sea; with another, it consisted in accounting for the solution of all terrestrial substances in one and the same menstruum; and with a third, in shewing how animals that were believed to be natives of the torrid zone could live in the frigid zone. Exhausting all the powers of the mind upon these questions, they conceived that they had done every thing that was necessary when they had contrived some method of answering them; and yet, while they neglected all the other phenomena, they did not always think of determining with precision the measure and limits of those which they had endeavoured to explain.

This is peculiarly the case with regard to the secondary formations, which constitute, however, the most important and most difficult part of the problem. During a long time, all that was done with respect to these, consisted of feeble attempts to determine the order of superposition of their strata, and the connections of these strata with the species of animals and plants whose remains they contain.

Are there certain animals and plants peculiar to certain strata, and not found in others? What are the species that appear first in order, and what those which succeed? Do these two kinds of species sometimes accompany each other? Are there alternations in their appearance; or, in other words, do the first reappear a second time, and do the others then disappear? Have these animals and plants all lived in the places where their remains are found, or have they been transported thither from other places? Do they all live at the present day in some part of the earth, or have they been partially or totally destroyed? Is there any constant connection between the antiquity of the strata and the resemblance, or non-resemblance, of the fossils contained in them to the animals and plants which now exist? Is there any connexion, in regard to climate, between the fossils and such living beings as resemble them most? May it be concluded, that the transportation of these living beings, if such a thing ever happened, has taken place from north to south, or from east to west; or were they irregularly scattered and mingled together; and can the epochs of these transportations be determined by the characters which they have impressed upon the strata?

What can be said regarding the causes of the existing state of the globe, if no reply can be made to these questions,—if there be no sufficient grounds to determine the choice between answering in the affirmative or negative? It is but too true, that, for a long time, none of these points was satisfactorily determined; and scarcely even would geologists seem to have had any idea of the propriety of clearing them up before constructing their systems.

Reason for which the Conditions of the Problem have been neglected.

The reason of this strange procedure will be discovered, when we reflect, that all geologists have hitherto been, either mere cabinet naturalists, who had themselves paid little atttention to the structure of mountains, or mere mineralogists, who had not studied in sufficient detail the innumerable varieties of animals, and the infinite complication of their various parts. The former of these have only constructed systems: the latter have furnished excellent observations, and have laid the foundation of true geological science; but have been unable to complete the edifice.

Progress of Mineral Geology.

The purely mineral part of the great problem of the Theory of the Earth has been investigated with admirable care by Saussure, and has been since carried to an astonishing degree of development by Werner, and by the numerous enlightened pupils of his school.

The former of these celebrated men, by a laborious investigation of the most inaccessible districts, continued for twenty years, in which he examined the Alps on all sides, and penetrated through all their defiles; has laid open to our view the entire disorder of the primitive formations, and has distinctly traced the limits by which they are distinguished from the secondary formations. The other, taking advantage of the numerous excavations made in the most ancient mining district in the world, has fixed the laws by which the succession of the strata are regulated, pointing out the relative antiquity of these strata, and tracing each of them through all its metamorphoses. It is from him, and from him alone, that we date the commencement of real geology, in so far as concerns the mineral nature of the strata: but neither he nor Saussure have determined the fossil organic species occurring in each kind of stratum, with the accuracy which has become necessary, now that the number of animals already known is so great.

Other naturalists, it is true, have examined the the fossil remains of organised bodies; they have collected and figured them by thousands, and their works will serve as so many precious collections of materials. But, considering these animals and plants more with reference to their own nature, than as connected with the theory of the earth; or regarding these petrifactions as curiosities, rather than as historical documents; or, lastly, contenting themselves with practical explanations regarding the position of each fragment, they have almost always neglected to investigate the general laws affecting the geological position of organic remains, or their connection with the strata.

Importance of Fossil Remains in Geology.

And yet, the idea of such an investigation was very natural; for it is abundantly obvious, that it is to these fossil remains alone that we owe even the commencement of a theory of the earth, and that, without them, we should perhaps never have even suspected that there had existed any successive epochs, and a series of different operations, in the formation of the globe. By them alone we are, in fact, enabled to ascertain, that the globe has not always had the same external crust; because, we are thoroughly assured, that the plants and animals must have lived at the surface before they had thus come to be buried deep beneath it. It is only by analogy that we have been enabled to extend to the primitive formations, the conclusion which is furnished directly for the secondary by the organic remains which they contain; and if there had only existed formations in which no fossil remains were inclosed, it could never have been shewn that these formations had not all been of simultaneous origin.

It is also by means of the organic remains, slight as is the knowledge we have hitherto acquired of them, that we have been enabled to discover the little that we yet know respecting the nature of the revolutions of the globe. From them we have learned, that the strata in which they are buried have been quietly deposited in a fluid; that their variations have corresponded with those of the fluid in question; that their being laid bare has been occasioned by the transportation of this fluid to some other place; and that this circumstance must have befallen them more than once. Nothing of all this could have been known with certainty, had no fossil remains existed.

The study of the mineral part of geology, though not less necessary, and even of much more utility to the practical arts, is yet much less instructive with reference to the object of our present inquiry.

We remain in utter ignorance respecting the causes which have given rise to the variety in the mineral substances of which the strata are composed. We are even ignorant of the agents which may have held some of these substances in solution; and it is still disputed, respecting several of them, whether they have owed their origin to water or to fire. After all, philosophers are only agreed on one point, which is, that the sea has changed its place; and how should this have been known, unless by means of the fossil remains?

The organic remains, therefore, which have given rise to the theory of the earth, have, at the same time, furnished it with its principal illustrations;—the only ones, indeed, that have as yet been generally acknowledged.

It is this consideration which has encouraged us to investigate the subject. But the field is vast; and it is but a very small portion of it that could be cultivated by the labour of a single individual. It was necessary, therefore, to select a particular department; and the choice was soon made. The class of fossil remains which forms the subject of this work, engaged our attention at the very outset, because it appeared to us to be that which is the most fertile in precise results, and yet, at the same time, less known, and richer in new objects of research *.

High importance of the Fossil Bones of Quadrupeds.

It is obvious, in fact, that the fossil bones of quadrupeds must lead to more accurate conclusions than any other remains of organized bodies, and that for several reasons.

---

* My work has, in fact, proved how far this inquiry was yet new when I commenced it, notwithstanding the excellent labours of Camper, Pallas, Blumenbach, Merk, Sömmering, Rosenmüller, Fischer, Faujas, Home, and other learned men, whose works I have most scrupulously cited in such of my chapters as their researches are connected with.

In the first place, they indicate much more clearly the nature of the revolutions to which they have already been subjected. Shells certainly announce the fact, that the sea has once existed in the places where they have been formed; but the changes which have taken place in their species, when rigorously inquired into, may have arisen from slight changes in the nature of the fluid in which they lived, or merely in its temperature. They may even have been produced by causes still more accidental. We can never be perfectly assured that certain species, and even genera, inhabiting the bottom of the sea, and occupying certain fixed spaces, for a longer or shorter time, may not have been driven away and supplanted by other species or genera.

In regard to quadrupeds, on the contrary, every thing is precise. The appearance of their bones in strata, and still more of their entire carcases, announces, either that the stratum itself which contains them has, at a former period, been laid dry, or, at least, that dry land must have existed in its neighbourhood. Their disappearance renders it certain, that this stratum has been inundated, or that the dry land in question has ceased to exist. It is from them, therefore, that we learn with perfect certainty the important fact of repeated irruptions of the sea, which the shells and other marine productions could not of themselves have proved; and it is by a careful investigation of them, that we may hope to ascertain the number and the epochs of these irruptions.

Secondly, The nature of the revolutions which have altered the surface of the globe, must have exerted a more powerful action upon terrestrial quadrupeds, than upon marine animals. As these revolutions have consisted chiefly of changes in the bed of the sea, and as the waters must have destroyed all the quadrupeds which they reached, if their irruption was general, it would necessarily have destroyed the entire class; or if it only overwhelmed certain continents at one time, it would at least have destroyed the species peculiar to those continents, without having the same effect upon the marine animals. On the other hand, millions of aquatic animals would have been left dry, or buried under newly-formed strata, or thrown violently on the coasts; while their races would still have been preserved in some more peaceful parts of the sea, whence they might again be propagated after the agitation of the waters had ceased.

Thirdly, This more complete action is also more easily ascertained. It is more easy to demonstrate its effects, because, the number of quadrupeds being limited, and the greater part of their species, at least the large ones, being known, we have more means of determining whether fossil bones belong to them, or to a species that is now lost. As, on the other hand, we are very far from being acquainted with all the testaceous animals and fishes which inhabit the sea, and as we are still probably ignorant of the greater number of those which live in deep water, it is impossible to know with certainty, whether a species which occurs in a fossil state, may not still exist somewhere alive. And hence, we see naturalists persisting in giving the name of pelagic shells, that is to say, shells inhabiting the open sea, to the belemnites, cornua-ammonis, and other testaceous remains, which have hitherto been found only in the older strata; meaning by this, that if they have not yet been discovered in a living state, it is because they inhabit the depths of the sea, far beyond the reach of our nets.

Small probability of discovering New Species of large Quadrupeds.

Naturalists, certainly, have not yet explored all the continents, nor do they even know all the quadrupeds which inhabit the countries that they have explored. New species of this class are discovered from time to time; and those who have not examined with attention all the circumstances belonging to these discoveries, might also imagine that the unknown quadrupeds, whose bones are found in our strata, may remain to this day concealed, in some islands not yet discovered by navigators, or in some of the vast deserts which occupy the middle of Asia, Africa, the two Americas, and New Holland.

However, if we carefully examine what kinds of quadrupeds have been recently discovered, and in what circumstances they have been found, we shall see that there is little hope of our ever finding alive those which have hitherto been observed only in a fossil state.

Islands of moderate extent, and at a considerable distance from the continents or large islands, possess very few quadrupeds, and these, for the greater part, of diminutive size. When they happen to contain any of the larger species, these must have been carried to them from other countries. Bougainville and Cook found no other large quadrupeds than hogs and dogs in the South Sea Islands; and the largest species of the West India Islands was the *agouti*.

It is true that the great continents, such as Asia, Africa, the two Americas, and New Holland, possess large quadrupeds, and, generally speaking, contain species peculiar to each; insomuch, that whenever large countries of this description have been discovered, which their situation has kept isolated from the rest of the world, the class of quadrupeds which they contained has been found entirely different from any that existed elsewhere. Thus, when the Spaniards first penetrated into South America, they did not find a single species of quadruped the same as any of Europe, Asia, or Africa. The puma, the jaguar, the tapir, the cabiai, the lama, the vicuna, the sloths, the armadilloes, the opossums, and the whole tribe of sapajous, were to them entirely new animals, of which they had no idea. Similar circumstances have recurred in our own time, when the coasts of New Holland and the adjacent islands were first explored. The various species of kangaroo, phascolomys, dasyurus, and perameles, the flying phalangers, the ornithorynchi and echidnæ, have astonished naturalists by the strangeness of their conformations, which presented proportions contrary to all former rules, and were incapable of being arranged under any of the systems then in use.

If there yet remained some great continent to be discovered, we might still hope to become acquainted with new species, among which there might be found some having more or less similarity to those of which we have discovered the remains in the bowels of the earth. But it is sufficient to cast a glance over the map of the world, and see the innumerable directions in which navigators have traversed the ocean, in order to be satisfied that there remains no other large land to be discovered, unless it may be situated towards the South Pole, where the existence of life would necessarily be precluded by the accumulation of ice.

Hence, it is only from the interior of the large divisions of the world, that we can have any hope of still procuring quadrupeds hitherto unknown. But a little reflection will be sufficient to convince us, that our expectations from this source have as little foundation as from that of the islands.

Doubtless, the European traveller cannot easily traverse vast extents of countries, which are either destitute of inhabitants, or are peopled only with ferocious tribes; and this is more especially true with regard to Africa. But there is nothing to prevent the animals themselves from roaming over these countries in all directions, and penetrating to the coasts. Even when there may be great chains of mountains between the coasts and the deserts of the interior, they must always be broken in some places to allow the rivers to pass through; and, in these burning deserts, the quadrupeds naturally follow the banks of rivers. The inhabitants of the coasts also ascend these rivers, and soon become acquainted with all the remarkable species which exist even to their sources, either from personal observation, or by means of intercourse with the inhabitants of the interior. At no period, therefore, could civilized nations have frequented the coast of a large country for any considerable length of time, without gaining some tolerable knowledge of such of the animals which it contained as were remarkable for their size or configuration.

This reasoning is confirmed by well known facts. Although the ancients never passed the mountains of Imaus, or crossed the Ganges, in Asia; and, although they never penetrated very far beyond Mount Atlas, in Africa; yet were they, in reality, acquainted with all the large animals of these two divisions of the world; and, if they have not distiuguished all the species, it was not because they had not seen them, or heard them spoken of by others, but because the mutual resemblances of some of these species caused them to be confounded together. The only important exception which can be opposed to this assertion, presents itself in the Tapir of Malacca, recently sent home from India by two young naturalists, pupils of mine, Messrs Duvaucel and Diard, and which in fact is one of the most interesting discoveries with which Natural History has been enriched in these latter times.

The ancients were perfectly acquainted with the Elephant; and the history of that quadruped is given more accurately by Aristotle than by Buffon. They were not even ignorant of some of the differences which distinguish the elephants of Africa from those of Asia *.

They knew the two-horned Rhinoceros, which has never been seen alive in modern Europe. Domitian exhibited it at Rome, and had it stamped on his medals, which have been very well described by Pausanias.

The one-horned Rhinoceros, distant as was its country, was equally known to them. Pompey shewed one at Rome; and Strabo has accurately described another which he saw at Alexandria †.

The Rhinoceros of Sumatra described by Mr Bell; and that of Java, discovered and sent home by Messrs Duvaucel and Diard, do not appear to inhabit the continent. Hence, it is not surprising, that the ancients should have been ignorant of them; besides, they probably would not have distinguished them from the others.

The Hippopotamus has not been so well described as the preceding animals; yet very exact representations of it have been left by the Romans in their monuments relative to Egypt, such as the statue of the Nile, the Palestrine pave-

---

* This is more particularly noticed in the Chapter on Elephants in the first volume of Professor Cuvier's *Recherches.*

† See the history of the Rhinoceros in the first part of the second volume of Professor Cuvier's *Recherches.*

ment, and a great number of medals. In fact, this animal was repeatedly seen by the Romans; having been exhibited by Scaurus, Augustus, Antoninus, Commodus, Heliogabalus, Philip, and Carinus *.

The two species of Camel, the Bactrian and Arabian, are both very well described and characterized by Aristotle †.

The Giraffe, or Camelopard (Camel-Leopard), was also well known to the ancients. A live one was shewn at Rome, in the circus, during the dictatorship of Julius Cæsar, in the year of Rome 708; and ten of them were exhibited together by Gordian III. all of which were killed at the secular games of Philip ‡,—a circumstance which may well surprise the moderns, who have only witnessed a single individual, which was sent by the Soldan of Egypt to Laurentius de Medicis, in the fifteenth century, and is painted in the frescoes of Poggio-Cajano.

If we read with attention the descriptions of the Hippopotamus, given by Herodotus and Aristotle, and which are supposed to have been borrowed from Hecatæus of Miletum, we shall

---

* See the chapter on the Hippopatamus, in the first volume of *Recherches*.

† Hist. Anim. Lib. ii. cap. 1.

‡ Jul. Capitol., Gord. iii. cap. 23.

find, that they must have been made up from two different animals, one of which was perhaps the true hippopotamus, and the other was assuredly the Gnou*, a quadruped, of which our naturalists begin to take notice only about the end of the eighteenth century. It is the same animal of which fabulous accounts were given by Pliny and Ælian, under the name of *catoblepas* and *catablepon* †.

The Ethiopian Boar of Agatharchides, which is described as having horns, is precisely the Ethiopian Boar of modern times, the enormous tusks of which deserve the name of horns nearly as much as those of the elephant ‡.

The Bubalus and Nagor are described by Pliny §; the Gazelle by Ælian ||; the Oryx by Oppian ¶; the Axis, so early as the time of Ctesias **; and the Algazel, and Corinne, are accurately figured upon the Egyptian monuments ††.

---

* Antilope Gnu, Gmel.

† Pliny, Lib. viii. cap. 32.; and Ælian, Lib. vii. cap. 5.

‡ Ælian, Anim. v. 27.

§ Pliny, lib. viii. cap. 15.; and lib. xi. cap. 37.

|| Ælian, Anim. xiv. 14.

¶ Opp. Cyneg., ii. v. 445. et seq.

** Pliny, lib. viii. cap. 21.

†† See the great Work upon Egypt, Antiq. iv. pl. 49.; and pl. 66.

Ælian has well described the *Bos grunniens* or Yak, under the name of the ox having a tail which serves for a fly-flapper [*].

The Buffalo was not domesticated by the ancients; but the Indian Ox, of which Ælian speaks [†], and which had horns large enough to hold three amphoræ, was assuredly that variety of the buffalo which is now called the *arnee*. And even the wild ox with depressed horns, which is mentioned by Aristotle as inhabiting Arachosia, a province of ancient Persia, could be nothing else than the common buffalo [‡].

The ancients were acquainted with the hornless variety of the ox [§], and with the African oxen, whose horns, being only attached to the skin, moved with it [||]. They also knew the Indian oxen, which equalled the horse in speed [¶]; and those which were so small as not to exceed a he-goat in size [**]. Nor were the broad-tailed sheep unknown to them [††],—nor those of India, which were said to be as large as asses [‡‡].

Although the accounts left us by the ancients, respecting the Aurochs, the Rein-deer, and Elk, are all mingled with fable, they are yet sufficient to prove that these animals were in some degree known to them, but that the reports which had reached them, had been communicated by ignorant people, and had not been corrected by a judicious examination [*]. These animals still inhabit the countries which the ancients assigned to them; and have only disappeared in such of them as have been too much cultivated for their habits. The aurochs [†] and elk still exist in the forests of Lithuania, which were formerly continuous with the great Hercynian Forest. The former of these animals still occurs in the northern parts of Greece, as it did in the days of Pausanias. The rein-deer inhabits the snowy regions of the north, where it always had its abode; it changes its colour, not at pleasure, but according to the change of the seasons. It was in consequence of mistakes scarcely excusable, that it was imagined to have occurred in the Pyrenees in the fourteenth century [‡].

---

[*] Ælian, Anim. xv. 14.

[†] Idem, Anim. iii. 34.

[‡] Arist. Hist. Anim. lib. ii. cap. 5.

[§] Ælian, ii. 53.

[||] Idem, ii. 20.

[¶] Idem, xv. 24.

[**] Idem, xv. 24.

[††] Idem, Anim. iii. 3.

[‡‡] Idem, iv. 32.

---

[*] This is more particularly explained in the chapters upon Deer and Oxen, in the fourth volume of Professor Cuvier's *Recherches*.

[†] Aurochs is Bos Urus, Lin., not the Urus of the ancients, which latter appears now to be extinct.

[‡] Buffon having read in Du Fouilloux a mutilated passage of Gaston-Phébus, Count de Foix, in which that prince describes the chace of the rein-deer, imagined that, in the time of Gaston, this animal lived in the Pyrenees; and the

Even the White Bear had been seen in Egypt while under the Ptolemies [*].

Lions and Panthers were common at Rome, where they were presented by hundreds in the games of the Circus. Even several Tigers were exhibited there, as well as the Striped Hyena and the Crocodile of the Nile. In the ancient mosaics preserved at Rome, there are excellent representations of the rarest of these animals. Among others, the striped hyena is seen represented with accuracy in a fragment preserved in the Museum of the Vatican; and, while I was at Rome in 1809, a mosaic pavement, composed of natural stones, arranged in the Florentine manner, was discovered in a garden beside the triumphal arch of Galienus, which represented four Bengal tigers executed in a superior manner.

In the Museum of the Vatican, there is deposited the figure of a crocodile in basalt, which is almost a perfect representation of that animal [†].

---

printed editions of Gaston were so faulty, that it was difficult to make out, with certainty, what the author had intended to say; but having had recourse to his original manuscript, which is preserved in the Royal Library, I have ascertained that it was in *Xueden* and *Nourvègue*, (Sweden and Norway), that he relates having seen and hunted the rein-deer.

[*] Athenæis, lib. v.

[†] The only error committed, is that of giving it a claw

It cannot in the least be doubted, that the *Hippotigris* was the Zebra, which, however, is only found in the southern parts of Africa [*].

It would be easy to shew that almost all the more remarkable species of Apes and Monkeys have been distinctly indicated by the ancients, under the names of *Pitheci*, *Sphinxes*, *Satyri*, *Cebi*, *Cynocephali*, and *Cercopitheci* [†].

They even knew, and have described several species of Glires of inconsiderable size, when these animals presented any thing remarkable in their conformation or properties [‡]. But the small species are of no importance with reference to the object in view; and, it is sufficient for our purpose to have shewn, that all the large species, which possess any remarkable character, and which we know to inhabit Europe, Asia, and Africa, at the present day, were known to the ancients;

---

too much to the hind foot. Augustus exhibited thirty-six of them; Dion, lib. lv.

[*] Caracalla killed one of them in the Circus; Dion, lib. lxxvii. Consult also Gisb. Cuperi de Eleph. in nummis obviis, ex. ii. cap. vii.

[†] See Lichtenstein, Comment. de Simiarum quotquot veteribus innotuerunt formis. Hamburgh, 1791.

[‡] The Jerboa is impressed upon the medals of Cyrene, and indicated by Aristotle under the name of *Two-legged Rat*.

whence we may fairly conclude, that their silence in respect to the small quadrupeds, and their neglect in distinguishing the species which very nearly resemble each other, as the various species of antelopes, and of some other genera, were occasioned by want of attention and ignorance of methodical arrangement, rather than by any difficulty proceeding from climate. We may also conclude, with equal certainty, that, as the lapse of eighteen or twenty centuries, together with the advantages of circumnavigating Africa, and of penetrating into India, have added nothing in this department to the information left us by the ancients, there is no probability that succeeding ages will add much to the knowledge of our posterity.

But perhaps some persons may be disposed to employ an opposite train of argument, and to allege that the ancients were not only acquainted with as many large qradupeds as we are, as has already been shewn, but that they have described several others which we do not now know,—that we act rashly in considering these animals as fabulous,—that we ought to search for them before concluding that we have exhausted the history of the present animal creation,—and, in fine, that among those animals which we presume to be fabulous, we may, perhaps, discover, when we become better acquainted with them, the originals of those bones of unknown animals which we discover buried in the earth. Some may even conceive, that those various monsters, which constitute the essential ornaments of the history of the heroic ages of almost all countries, are precisely those very species which it was necessary to destroy, in order to allow the establishment of civilization. Thus the Theseuses and Bellerophons of ancient times had been more fortunate than all the nations of our days, which have only been able to drive back the noxious animals, but have never yet succeeded in exterminating a single species.

Inquiry respecting the Fabulous Animals of the Ancients.

It is easy to reply to the foregoing objection, by examining the descriptions of these unknown beings, and by inquiring into their origins. The greater number of them have an origin purely mythological, and of this origin their descriptions bear unequivocal marks; for in almost all of them we see merely parts of known animals united by an unbridled imagination, and in contradiction to all the laws of nature.

Those which were invented or arranged by the Greeks, have at least the merit of possessing elegance in their composition. Like those arabesques which decorate the remains of some ancient buildings, and which have been multiplied by the fertile pencil of Raphael, the forms which they combine, however repugnant to reason they may be, present agreeable contours. They are the fantastic productions of playful genius; perhaps emblematic representations in the oriental taste, in which were supposed to be concealed under mystical images certain propositions in metaphysics or in morals. We may excuse those who employ their time in attempts to discover the wisdom concealed in the sphinx of Thebes, the pegasus of Thessaly, the minotaur of Crete, or the chimera of Epirus; but it would be absurd to expect seriously to find such productions in nature. As well might we search for the animals described in the Book of Daniel, or for the beast of the Apocalypse.

Neither may we look for the mythological animals of the Persians, creatures of a still bolder imagination: the *martichore*, or man-destroyer, bearing a human head on the body of a lion, terminated by the tail of a scorpion *; the *griffon*, guardian of treasures, half eagle, half lion †; the

---

* Plin. viii. 31. Arist. lib. ii. cap. 40. Phot. Bibl., Art. 72; Ctes. Indic. Ælian. Anim., iv. 21.

† Ælian, Anim. iv. 27.

cartazonon, or wild ass, armed with a long horn on its forehead *.

Ctesias, who has described these as real animals, has been looked upon by many authors as an inventor of fables; whereas he has merely attributed an actual existence to emblematical figures. These imaginary compositions have been seen in modern times sculptured upon the ruins of Persepolis †. What they were intended to signify we shall probably never know; but of this much we are certain, that they do not represent actual beings.

Agatharchidas, another fabricator of animals, drew his information in all probability from a similar source. The ancient Egyptian monuments still furnish us with numerous fantastic representations, in which the parts of different species are combined: gods are often figured with a human body and the head of an animal, and animals are seen with human heads; thus giving rise to the cynocephali, sphinxes, and satyrs of ancient naturalists. The custom of representing in the same painting men of very different sizes, of making the king or the conqueror gigantic, the subjects or the conquered three or four times smaller, must have given rise to the fable of the pigmies. It was in some corner of one of these monuments that Agatharchidas must have seen his carnivorous bull, which, with mouth extending from ear to ear, devoured every other animal[*]. Certainly no naturalist would admit the existence of such an animal; for nature never combines either cloven hoofs or horns with teeth adapted for devouring animal food.

---

* Ælian, xvi. 20. Photius, Bibl., art. 72. Ctes. Indic.

† See Corneille Lebrun, Voyage en Muscovie, en Perse et aux Indes, tom. ii. See also the German work by M. Heeren, on the Commerce of the Ancients.

There may perhaps have been many other figures equally strange, either among such of these monuments as have not been able to resist the ravages of time, or in the temples of Ethiopia and Arabia, which have been destroyed by the religious zeal of the Mahometans and Abyssinians. The monuments of India teem with such figures; but the combinations in these are too extravagant to have deceived any one. Monsters with a hundred arms, and twenty heads all different from one another, are far too absurd to be believed. Nay, the inhabitants of Japan and China also have their imaginary animals, which they represent as real, and which figure even in their religious books. The Mexicans had them. In short, they are the fashion among all nations, whether at the periods when their idolatry has not yet been refined, or when the import of these emblematical combinations has been lost. But who would dare to affirm that he had found those productions of ignorance and superstition in nature? And yet it may have happened that travellers, influenced by a desire of making themselves famous, might pretend that they had seen those strange beings, or that, deceived by a slight resemblance, into which they were too careless to enquire, they may have taken real animals for them. In the eyes of such people, large baboons or monkeys may have appeared true cynocephali, sphinxes, or men with tails. It is thus that St Augustin may have imagined he had seen a satyr.

---

[*] Photius, Bibl., art. 250. Agatharchid., Excerpt. hist., cap. xxxix. Ælian, Anim xvii. 45. Plin. viii. 21.

Some real animals, inaccurately observed and described, may have given rise to monstrous ideas, which, however, have had their foundation in some reality. Thus, we can have no doubt of the existence of the hyena, although that animal has not its neck supported by a single bone*, and although it does not change its sex every year, as Pliny alleges*. Thus, also, the carnivorous bull is perhaps nothing else than a two-horned rhinoceros erroneously described. M. de Weltheim affirms with probability, that the auriferous ants of Herodotus are *corsacs*.

---

* I have even seen, in the collection of the late Mr Addrien Camper, a skeleton of a hyena, in which several of the vertebræ of the neck were anchylosed. It was probably from seeing some similar individual that the character in question was attributed to all hyenas. This animal ought to be more subject than any other to such an accident, on

One of the most famous amongst these fabulous animals of the ancients, is the *unicorn*. Even in our own time people have obstinately persisted in searching for it, or, at least, in seeking arguments to prove its existence. Three several animals are frequently mentioned by the ancients as having only one horn in the middle of the forehead. The *African oryx*, having cloven hoofs, the hair placed in the contrary direction to that of other animals †, equal in size to the bull ‡, or even the

---

account of the prodigious power of the muscles of its neck, and the frequent use which it makes of them. When the hyena has laid hold of any thing, it is easier to drag it along by it than to wrest it from its jaws; and it is this circumstance which has caused the Arabs to consider it as the emblem of invincible obstinacy.

* It does not in reality change its sex, but it has an orifice in the perineum, which might make it be supposed to be hermaphrodite.

† Arist. Anim. ii. 1. iii. 1. Plin. xl. 46.

‡ Herod. iv. 192.

rhinoceros[*], and said to resemble deer and goats in form[†]; the *Indian ass*, having solid hoofs; and the *monoceros*, properly so called, whose feet are sometimes compared to those of the lion[‡], and sometimes to those of the elephant[§], and which is therefore considered as having divided feet. The one-horned horse[||] and one-horned bull are doubtless both to be referred to the Indian ass, for even the latter is described as having solid hoofs[¶]. I would ask, If these animals exist as distinct species, should we not at least have their horns in our collections? And what single horns do we possess, excepting those of the rhinoceros and narwal?

How is it possible, after this, to refer to rude figures traced by savages upon rocks[**]? Ignorant of perspective, and wishing to represent a straight horned antelope in profile, they could only give it a single horn, and thus they produced an oryx. The oryxes, too, that are seen on the Egyptian monuments, are probably nothing more than productions of the stiff style, imposed upon the artists of that country by their religion. Many of their profiles of quadrupeds shew only one fore and one hind leg; and this being the case, why should they have shewn two horns? It may perhaps have chanced that individuals have been taken in the chace, which had accidentally lost one of their horns, as pretty frequently happens to the chamois and saiga: and this would have been sufficient to confirm the error produced by these representations. It is probably in this way that the unicorn has recently been reported to be found in the mountains of Thibet.

---

[*] Oppian, Cyneg. ii. vers. 551.

[†] Plin. viii. 53.

[‡] Philostorg. iii. 11.

[§] Plin. viii. 21.

[||] Onesicrit, ap. Strab. lib. xv. Ælian, xiii. 42.

[¶] Plin. viii. 31.

[**] Barrow's Voyage to the Cape, Fr. transl. ii. 178.

All the ancients, however, have not represented the oryx as having only one horn. Oppian expressly gives it several [*], and Ælian mentions oryxes which had four [†]. Finally, if this animal was ruminant and cloven-hoofed, we know assuredly that its frontal bone must have been longitudinally divided into two, and that it could not, as is very justly remarked by Camper, have had a horn placed upon the suture.

But it may be asked, What two-horned animal could have given the idea of the oryx, and presented the characters which it is described as possessing with regard to its conformation, even independent of the notion of a single horn? To this I reply, with Pallas, that it was the straight horned antelope, the *Antilope oryx* of Gmelin, improperly named *pasan* by Buffon. It inhabits the deserts of Africa, and must approach the confines of Egypt. It is this animal which the hieroglyphics appear to represent. Its form is nearly that of the stag; its size equals that of the bull; the hair of its back is directed toward the head; its horns form exceedingly formidable weapons, pointed like javelins, and hard as iron; its hair is whitish, and its face is marked with spots and streaks of black. Such is the description given of it by naturalists; and the fables of the Egyptian priests, which have occasioned the insertion of its figure among their hieroglyphics, do not require to have been founded in nature. Supposing, therefore, that an individual of this species had been seen which had lost one of its horns by some accident, it might have been taken as a representative of the whole race, and erroneously adopted by Aristotle, and copied by his successors. All this is possible, and even natural, and yet proves nothing with regard to the existence of a single-horned species.

---

[*] Oppian, Cyneg, lib. II. v. 468. and 471.

[†] De Anim. lib. xv. cap. 14.

In regard to the Indian ass, if we attend to the properties ascribed to its horns as an antidote against poison, we shall see that they are precisely the same as those which the eastern nations attribute at the present day to the horn of the rhinoceros. When this horn was first imported into Greece, the animal to which it belonged might still have been unknown. In fact, Aristotle makes no mention of the rhinoceros, and Agatharchides was the first who described it. In the same manner, ivory was in use among the ancients long before they were acquainted with the elephant. It is even possible that some of their travellers might have given to the rhinoceros the name of *Indian ass*, with as much propriety as the Romans denominated the elephant the *bull of Lucania*. Every, thing, moreover, that is said of the strength, size, and ferocity of this wild ass of theirs, corresponds very well with the rhinoceros. In succeeding times, naturalists, who had now become better acquainted with the rhinoceros, finding this denomination of *Indian ass* in the writings of authors who had preceded them, might have taken it, from want of proper examination, for that of a distinct animal; and from the name, they would have concluded the animal should have solid hoofs. There is, indeed, a full description of the Indian ass given by Ctesias*, but we have seen above that it had been taken from the bas-reliefs of Persepolis, and must therefore go for nothing in the real history of the animal.

---

* Ælian, Anim. iv. 52; Photius, Bibl. p. 154.

When there afterwards appeared more exact descriptions of an animal having a single horn only, but with several toes, a third species would have been made out, to which they gave the name of *monoceros*. These double references applied to the same species, are more frequent among ancient naturalists, because most of their works which have come down to us were mere compilations; even because Aristotle himself has frequently mingled facts borrowed from others with those which he had observed himself; and because the habit of critical examination was then as little known among naturalists as among historians.

From all these reasonings and digressions, it may be fairly concluded, that the large animals of the old continent with which we are now acquainted, were known to the ancients; and that the animals described by the ancients, and which are now unknown, were fabulous. It also follows, that the large animals of the three principal parts of the then discovered world could not have been long in being known to the nations which frequented their coasts.

It may also be concluded, that no large species remains to be discovered in America. If there were any, there can be no reason why we should not be acquainted with it; and in fact none has been discovered there during the last hundred and fifty years. The tapir, the jaguar, the puma, the cabiai, the lama, the vicunna, the red wolf, the buffalo or American bison, the ant-eaters, sloths and armadilloes, are as well described by Margrave and Hernandez as by Buffon; it may even be said that they are better, for Buffon has confused the history of the ant-eaters, mistaken the jaguar and red wolf, and confounded the bison of America with the aurochs of Poland. Pennant, it is true, was the first naturalist who clearly distinguished the small musk ox; but it was long before made mention of by travellers. The cloven-footed horse of Molina, has not been described by the early Spanish travellers; but its existence is more than doubtful, and the authority of Molina is too suspicious to authorise our adopting it. It might be possible to characterise more accurately than has been done the different species of deer belonging to America and India; but the case is with respect to these animals as it was among the ancients with respect to the antelopes; it is the want of a good method for distinguishing them, and not of opportunities of seeing them, that has left them so imperfectly known to us. It may, therefore, be said, that the Mouflon of the Blue Mountains is the only American quadruped of any considerable size of which the discovery is altogether modern; and even it is perhaps only an argali that may have crossed upon the ice from Siberia.

How should it be thought, after this, that the huge *mastodons* and gigantic *megatheria*, whose bones have been discovered under ground in North and South America, still exist alive on that continent? How should they have escaped those wandering tribes which continually traverse the country in all directions, and which are themselves aware that these animals no longer exist, since they have invented a fabulous account of their destruction, alleging that they were killed by the Great Spirit, to prevent them from extirpating the human race. But it is evident that this fable has been occasioned by the discovery of the bones, like that of the inhabitants of Siberia with respect to their mammoth, which they pretend to live under ground like the mole, and, like all those of the ancients, about the graves of giants, who were thought by them to have been buried wherever the bones of elephants were discovered.

Thus it may safely be concluded, that if, as we have just said, none of the large species of quadrupeds whose remains are at the present day found in regular mineral strata, bear resemblance to any of the known living species, this is not the effect of mere chance, nor because those species of which we possess nothing but the bones, are still concealed in the deserts, and have hitherto eluded the observation of travellers. On the contrary, this phenomenon must be regarded as resulting from general causes; and its investigation may be considered as affording one of the best means for discovering the nature of these causes.

Difficulty of determining the Fossil Bones of Quadrupeds.

If this study is more satisfactory in its results than that of other fossil remains of animals, it is also beset with more numerous difficulties. Fossil shells usually present themselves in an entire state, and with all the characters requisite for comparing them with their analogous species, preserved in the collections or figured in the works of naturalists. Even fishes present their skeleton more or less entire; the general form of their body is almost always distinguishable, and most commonly, also, their generic and specific characters, which are drawn from their solid parts. In quadrupeds, on the contrary, even should the skeleton be found entire, it would be difficult to apply to it characters derived, for the most part, from the hair, the colours, and other marks which have disappeared previous to their incrustation. It is even excessively rare to find a fossil skeleton approaching in any considerable degree to a complete state. The strata, for the most part, only contain separate bones, scattered confusedly, and almost always broken, and reduced to fragments; and these constitute the only resources of knowledge to the naturalist in this department. It may also be stated, that most observers, deterred by these difficulties, have passed slightly over the fossil bones of quadrupeds; have classed them in a vague manner, according to superficial resemblances, or have not even ventured to assign them a name; so that this part of the history of fossil remains, although the most important and most instructive of all, is, at the same time, that which has been the least cultivated *.

Principle by which this determination is effected.

Fortunately, comparative anatomy possesses a principle, which, when properly developed, enables us to surmount all the obstacles. This principle consists in the mutual relation of forms in organised beings, by means of which, each species may be determined, with perfect certainty, by any fragment of any of its parts.

Every organised being forms a whole,—a peculiar system of its own, the parts of which mutually corrrespond, and concur in producing the same definitive action, by a reciprocal reaction. None of these parts can change in form, without the others also changing; and consequently, each of them, taken separately, indicates and ascertains all the others.

---

* I do not intend by this remark, as I have already observed on a former occasion, to detract from the merit of the observations of Camper, Pallas, Blumenbach, Sœmmering, Merk, Faugas, Rosenmüller, Home, &c.; but their excellent works, which have been very useful to me, and which I quote throughout, are incomplete; and several of these works have only been published since the first editions of this Essay.

Thus, if the intestines of an animal are so organised as to be fitted for the digestion of flesh only, and that flesh recent, it is necessary that its jaws be so constructed as to fit them for devouring live prey; its claws for seizing and tearing it; its teeth for cutting and dividing it; the whole system of its organs of motion, for pursuing and overtaking it; and its organs of sense for discovering it at a distance. It is even requisite that nature have placed in its brain the instinct necessary for teaching it to conceal itself, and to lay snares for its victims.

Such are the general conditions which nature imposes upon the structure of carnivorous animals; and which every animal of this description must indispensably combine in its constitution, for without them its race could not subsist. But subordinate to these general conditions, there exist others, having relation to the size, the species, and the haunts of the prey for which the animal is adapted; and from each of these particular conditions, there result modifications of detail in the forms which arise from the general conditions.

Thus not only the class, but the order, the genus, and even the species, are found expressed in the form of each part.

In fact, in order that the jaw may be able to seize, it must have a certain form of condyle; that the resistance, the moving power, and the fulcrum, should have a certain relative position in regard to each other; and that the temporal muscles should be of a certain size; the hollow or depression, too, in which these muscles are lodged, must have a certain depth; and the zygomatic arch, under which they pass, must not only have a certain degree of convexity, but it must be sufficiently strong to support the action of the masseter.

In order that the animal may be able to carry off its prey, it must have a certain degree of vigour in the muscles which elevate the head; whence there results a determinate form in the vertebræ from which these muscles take their rise, and in the occiput into which they are inserted.

In order that the teeth may be able to cut flesh, they must be sharp-edged, and must be so in a greater or less degree, according as they have flesh more or less exclusively to cut. Their base will be solid, according to the quantity and size of the bones which they have to break. The whole of these circumstances must necessarily influence the development and form of all the parts which contribute to move the jaws.

In order that the paws may be able to seize the prey, there must be a certain degree of mobility in the toes, and a certain degree of strength in the claws, from which there will result determinate forms in all the phalanges, and a corresponding distribution of muscles and tendons. The fore-arm, or cubitus, must possess a certain facility of turning, from which there will also result determinate forms in the bones of which it is composed. But the bones of the cubitus being articulated to the humerus, a change in the proportions of the former, will necessarily induce a corresponding change in the latter. The shoulder-bones must have a certain degree of firmness in such animals as make use of their fore-legs for seizing, and from this there must also result a certain peculiarity in their form. The play of all these parts will require certain proportions in all their muscles, and the impressions made by these muscles so proportioned, will determine still more particularly the forms of the bones.

It is easy to see that similar conclusions may be drawn with regard to the posterior extremities which contribute to the rapidity of the general motions; with regard to the composition of the trunk, and the forms of the vertebræ, which exert an influence upon the facility and flexibility of these motions; and, lastly, with regard to the forms of the bones of the nose, of the orbit, and of the ear, the connection of which with the perfection of the senses of smell, sight, and hearing, is evident. In a word, the form of the tooth regulates the forms of the condyle, of the scapula, and of the claws, in the same manner as the equation of a curve regulates all its properties; and as, by taking each property separately for the base of a particular equation, we find both the ordinary equation, and all the other properties whatever; so, the claw, the scapula, the condyle, the femur, and all the other bones taken separately, give the tooth, or are reciprocally given by it; and thus, by commencing with any one of these bones, a person who possesses an accurate knowledge of the laws of organic economy, may reconstruct the whole animal.

This principle seems sufficiently evident, in the general acceptation in which it is here taken, and does not require any fuller demonstration; but when it comes to be applied, there will be found many cases where our theoretical knowledge of the relations of forms will not be sufficient, unless it be supported by observation and experience.

For example, we are well aware, that hoofed animals must all be herbivorous, since they have no means of seizing prey. It is also evident, that, having no other use to make of their fore-legs than to support their body, they do not require a shoulder so vigorously organised as that of carnivorous animals; they have, therefore, no acromion or clavicle, and their shoulder-blades are narrow. Having also no occasion to turn their fore-arm, their radius is united to the ulna by ossification, or at least articulated by a ginglimus or hinge-joint, and not by arthrodia or ball and socket, to the humerus. Their food being herbaceous, will require teeth furnished with flat surfaces, for bruising seeds and plants. The crown of the teeth must also be unequal, and, for this purpose, must be composed of parts alternately consisting of bone and of enamel. Teeth of this structure necessarily require horizontal motions to enable them to triturate the food; and hence the condyle of the jaw cannot be so strictly confined within its articulating cavity as in the carnivorous animals, but must be flattened, and thus correspond with a more or less flattened surface of the temporal bones. Further, the temporal fossa, which will only have a small muscle to contain, will be narrower, and not so shallow, as that of carnivorous animals. All these circumstances are deducible from each other, according to their greater or less generality, and in such a manner, that some of them are essential and exclusively peculiar to hoofed animals, while others, although equally necessary in these animals, are not entirely peculiar to them, but may occur in other animals also, where the rest of the conditions will permit their existence.

If we proceed to consider the orders or subdivisions of the class of hoofed animals, and examine what modifications the general conditions undergo, or rather what particular conditions are conjoined with them, according to the respective characters of these orders, the reasons of these subordinate conditions begin to appear less obvious. We can still easily conceive, in general, the necessity of a more complicated system of digestive organs in those species which have a more imperfect masticatory system; and hence we may presume, that these latter must be rather ruminating animals, in which there is wanting such or such an order of teeth; and may also deduce from the same consideration, the necessity of a certain form of the œsophagus, and of corresponding forms in the vertebræ of the neck, &c. But I doubt whether it would have been discovered, independently of actual observation, that the ruminating animals should all have cloven hoofs, and that they should be the only animals having them; that there should be horns on the forehead in this class alone; or that such of them as have sharp canine teeth, should, in general, have no horns.

However, since these relations are constant, we may be assured that they have a sufficient cause; but as we are not acquainted with that cause, we must supply the defect of theory by means of observation, and in this way establish empirical laws which become nearly as certain as those deduced from rational principles, when founded upon observations, the authenticity of which is proved by frequent repetition. Hence, at the present day, any one who observes only the print of a cloven foot, may conclude that the animal which left this impression ruminates; and this conclusion is quite as certain as any other in physics, or in moral philosophy. This simple footmark, therefore, indicates at once to the observer the forms of the teeth, of the jaws, of the vertebræ, of all the bones of the legs, thighs, shoulders, and pelvis of the animal which had passed. It is a surer mark than all those of Zadig. That there are secret reasons, however, for all these relations, is what observation alone is sufficient to shew, independently of any general principles of philosophy.

In fact, when we construct a table of these relations, we remark not only a specific constancy, if the expression may be allowed, between a particular form of a particular organ, and some other form of a different organ; but we also perceive a classic constancy of conformation, and a corresponding gradation, in the development of these two organs, which demonstrate their mutual influence, almost as well as the most perfect deduction of reason.

For example, the dentary system of the hoofed animals, which are not ruminant, is in general more perfect than that of the cloven-footed or ruminating animals, because the former have either incisors, or canine teeth, and almost always both in each jaw; and the structure of their foot is in general more complicated, because they have more toes or claws, or their phalanges less enveloped in the hoof,—or a greater number of distinct bones in the metacarpus and metatarsus—or more numerous tarsal bones—or a fibula more distinct from the tibia—or, lastly, that all these circumstances are often united in the same species of animals.

It is impossible to assign reasons for these relations; but we are certain that they are not the effects of chance, because, whenever a cloven-footed animal manifests, in the arrangement of its teeth some tendency to approach the animals we now speak of, it also manifests a similar tendency in the arrangement of its feet. Thus the camels, which have canine teeth, and even two or four incisors in the upper jaw, have an additional bone in the tarsus, because their scaphoid bone is not united to the cuboid, and they have very small hoofs, with corresponding phalanges. The musk animals, whose canine teeth are much developed, have a distinct fibula along the whole length of their tibia; while the other cloven-footed animals have only, in place of a fibula, a small bone articulated at the lower end of the tibia. There is, therefore, a constant harmony between two organs apparently having no connection; and the gradations of their forms preserve an uninterrupted correspondence, even in those cases in which we cannot account for their relations.

Now, by thus adopting the method of observation as a supplementary means, when theory is no longer able to direct our views, we arrive at astonishing results. The smallest articulating surface of bone, or the smallest apophysis, has a determinate character, relative to the class, the order, the genus, and the species to which it belonged; insomuch, that when one possesses merely a well preserved extremity of a bone, he can, by careful examination, and the aid of a tolerable analogical knowledge, and of accurate comparison, determine all these things with as much certainty as if he had the entire animal before him. I have often made trial of this method upon portions of known animals, before reposing full confidence upon it, in regard to fossil remains; and it has always proved so completely satisfactory, that I have no longer any doubts regarding the certainty of the results which it has afforded me.

It is true, that I have enjoyed all the advantages which were necessary for the undertaking; and that my favourable situation, in the Museum of Natural History at Paris, and assiduous research for nearly thirty years, have procured me skeletons of all the genera and sub-genera of quadrupeds, and even of many species in some genera, and of several varieties of some species.

With such means, it was easy for me to multiply my comparisons, and to verify in all their details the applications which I have made of the various laws deducible from such circumstances as have been stated.

We cannot here enter into a more lengthened detail of this method, and must refer to the large work on Comparative Anatomy, in which all its rules will be found. In the mean time, an intelligent reader may gather a great number of these from the work upon Fossil Bones, if he take the trouble of attending to all the applications of them which we have there made. He will see, that it is by this method alone that we are guided, and that it has almost always sufficed for referring each bone to its species, when it was a living species—to its genus, when it was an unknown species—to its order, when it was a new genus—and to its class, when it belonged to an order not hitherto established—and to assign it, in the three last cases, the proper characters for distinguishing it from the nearest resembling orders, genera, and species. Before the commencement of our researches, naturalists had done no more than this with regard to animals, which they had the opportunity of examining in their entire state. Yet, in this manner, we have determined and classed the *remains* of more than a hundred and fifty mammiferous and oviparous quadrupeds.

View of the General Results of these Researches.

Considered with regard to species, upwards of ninety of these animals are most assuredly hitherto unknown to naturalists; eleven or twelve have so perfect a resemblance to species already known, that the slightest doubt cannot be entertained of their identity; the others exhibit many traits of resemblance to known species, but their comparison has not yet been made with sufficient precision to remove all doubts.

Considered with regard to genera, of the ninety hitherto unknown species, there are nearly sixty that belong to new genera. The other species rank under genera or subgenera already known.

It may not be without use, also, to consider these animals with regard to the classes and orders to which they belong. Of the hundred and fifty species, about a fourth part are oviparous quadrupeds, and all the rest mammifera. Of these last, more than the half belong to non-ruminant hoofed animals.

Notwithstanding what has been done, it would still be premature to establish upon these numbers any conclusion relative to the theory of the earth, because they are not in sufficient proportion to the numbers of genera and species which may be buried in the strata of the earth. Hitherto the bones of the larger species have been chiefly collected, these being more obvious to agricultural labourers; while the bones of the smaller species are usually neglected, unless when they chance to fall into the hands of a naturalist, or when some particular circumstance, such as their excessive abundance in certain places, attracts the attention even of the common people.

Relations of the Species of Fossil Animals with the Strata in which they are found.

The most important consideration, that which, in fact, is the chief object of all my researches, and which establishes their legitimate connection with the Theory of the Earth, is to ascertain in what strata each species is found, and whether there may be some general laws, relative either to the zoological subdivisions, or to the greater or less resemblance of the species to those of the present day.

The laws which have been recognised with respect to these relations are very distinct and satisfactory.

In the first place, it is clearly ascertained that the oviparous quadrupeds appear much more early than the viviparous; that they are even more abundant, larger, and more varied, in the ancient strata than at the surface of the globe, as it exists at present.

The Ichthyosauri, the Plesiosauri, several species of Tortoise, and several species of Crocodile, are found beneath the chalk, in the deposits commonly called *Jura formations*. The Monitors of Thuringia would be still older, if, according to the Wernerian School, the copper-slate in which they are contained, along with a great variety of fishes supposed to have belonged to fresh-water, is to be placed among the oldest beds of the secondary formations. The enormous crocodiles and the great tortoises of Maestricht, are found in the chalk formation itself; but these are marine animals.

This earliest appearance of fossil bones seems, therefore, already to indicate, that dry lands and fresh waters had existed before the formation of the chalk deposits. But neither at this period, nor while the chalk was forming, nor even long after, have any bones of land-mammifera been encrusted; or, at least, the small number of these, which are alleged to have been found in strata of these dates, forms but a trifling exception.

We begin to find bones of marine mammifera, namely, of lamantins and seals, in the coarse shelly limestone which covers the chalk in the neighbourhood of Paris; but there are still no bones of terrestrial mammifera.

Notwithstanding the most assiduous investigation, I have not been able to discover any distinct trace of this class in any of the deposits preceding those which rest upon the coarse limestone. Certain lignites and molasses do in fact contain them; but I am very doubtful whether these deposits are all, as is commonly supposed, anterior to that limestone. The places where these bones have been found are so limited, both in extent and in number, as to induce us to suppose some irregularity, or some repetition of the formation containing them. On the contrary, the moment we arrive at the deposits which rest upon the coarse limestone, the bones of land-animals present themselves in great abundance.

As it is reasonable to believe that shells and fishes did not exist at the period of the formation of primitive rocks, we are also led to conclude that the oviparous quadrupeds began to exist along with the fishes, and at the commencement of the period during which the secondary rocks were formed; but that the land-quadrupeds did not appear upon the earth, at least in any considerable number, till long after, and until the coarse limestone strata, which contain the greater number of our genera of shells, although of species different from ours, had been deposited.

It is remarkable that those coarse limestone strata which are used at Paris for building, are the last formed strata which indicate a long and quiet continuance of the sea upon our continents. Above them, indeed, there are found formations containing shells and other marine productions; but these consist of collections of transported matters, sand, marls, sandstones, and clays, which rather indicate transportations that have taken place with more or less violence, than strata formed by tranquil deposition; and, if there be some rocky and regular strata of pretty considerable magnitude, beneath or above these transported matters, they generally exhibit indications of having been deposited from fresh water.

Almost all the known bones of viviparous quadrupeds, therefore, have been found either in those fresh-water formations, or in the alluvial formations; and consequently there is every reason to conclude that these quadrupeds have only begun to exist, or, at least, to leave their remains in the strata of our earth, after the last retreat of the sea but one, and during the state of things that preceded its last irruption.

But there is also an order in the disposition of these bones with regard to each other; and this order further announces a very remarkable succession in the appearance of the different species. All the genera which are now unknown, the Palæotheria, Anaplotheria, &c., with the position of which we are thoroughly acquainted, belong to the oldest of the formations of which we are now speaking, those which rest immediately upon the coarse limestone. It is chiefly these genera which occupy the regular beds that have been deposited from fresh-water, or certain alluvial beds of very ancient formation, generally composed of sand and rolled pebbles, and which were perhaps the earliest alluvium of that ancient world. Along with these there are also found some lost species of known genera, but in small numbers, and some oviparous quadrupeds and fishes, which appear to have been all inhabitants of fresh-water. The beds which contain them are always more or less covered by alluvial beds, containing shells, and other marine productions.

The most celebrated of the unknown species, which belong to known genera, or to genera closely allied to those which are known, such as the fossil elephants, rhinoceroses, hippopotami, and mastodons, do not occur along with those more ancient genera. It is in the alluvial formations alone that they are discovered, sometimes accompanied with marine shells, and sometimes with fresh-water shells, but never in regular stony beds. Every thing that is found along with these species is either unknown like themselves, or at least doubtful.

Lastly, the bones of species which are apparently the same as those that are still found alive, are never discovered, except in the last alluvial deposits formed on the sides of rivers, or on the bottoms of ancient pools or marshes now dried up, or in the substance of beds of peat, or in the fissures and caverns of some rocks; or, lastly, at small depths below the surface, in places where they may have been buried by the falling down of debris, or even by the hand of man; and their superficial position renders these bones, although the most recent of all, almost always the worst preserved.

It must not, however, be thought that this classification of the various geological positions of fossil remains, is as certain as that of the species, or that it is equally capable of demonstration. There are numerous reasons which prevent this from being the case.

In the first place, all my determinations of species have been made upon the bones themselves, or by means of good figures; whereas it has been impossible for me personally to examine all the places in which these bones have been discovered. I have very frequently been obliged to content myself with vague and ambiguous accounts, given by people who were not themselves well aware of what it was necessary to observe; and, more frequently still, I have been unable to procure any information whatever on the subject.

Secondly, these repositories of organic remains are subject to infinitely greater doubts, than the bones themselves. The same formation may appear recent in places where it shews itself at the surface, and ancient in those where it is covered by the beds which have succeeded it. Ancient formations may have been transported by partial inundations, and thus have covered recent bones; they may have fallen upon them by crumbling, and thus have enveloped and mingled them with the productions of the ancient sea, which they previously contained. Bones of ancient periods may have been washed out by the waters, and afterwards enveloped in recent alluvial formations. Lastly, recent bones may have fallen into the fissures or caverns of ancient rocks, and been enveloped by stalactites or other incrustations. In every individual instance, therefore, it becomes necessary to analyze and appreciate all those circumstances which might disguise the real origin of fossil remains; and it rarely happens that people who have collected bones have been themselves aware of this necessity, the consequence of which has been, that the true characters of their geological position have been almost always neglected or misunderstood.

Thirdly, there are some doubtful species, which must occasion more or less uncertainty in the results of our researches, until they have been clearly ascertained. Thus the horses and buffaloes that occur along with the elephants, have not yet received appropriate specific characters; and such geologists as are disinclined to adopt the different epochs which I have endeavoured to establish with regard to fossil bones, may, for many years to come, draw from thence an argument against my system, so much the more convenient as it is contained in my own work.

But allowing that these epochs are liable to some objections, from such as may only consider some particular case, I am not the less satisfied, that those who shall take a comprehensive view of the phenomena, will not be checked by such inconsiderable and partial difficulties, and will be led to conclude, as I have done, that there has been at least one, and very probably two, successions in the class of quadrupeds, previous to that which at the present day peoples the surface of the earth.

Proofs that the Extinct Species of Quadrupeds are not varieties of the presently existing Species.

I now proceed to the consideration of another objection, one, in fact, which has already been urged against me.

Why may not the presently existing races of land quadrupeds, it has been asked, be modifications of those ancient races which we find in a fossil state; which modifications may have been produced by local circumstances and change of climate; and carried to the extreme difference which they now present, during a long succession of ages?

This objection must appear strong to those especially who believe in the possibility of indefinite alteration of forms in organised bodies; and who think that, during a succession of ages, and by repeated changes of habitudes, all the species might be changed into one another, or might result from a single species.

Yet to these persons an answer may be given from their own system. If the species have changed by degrees, we ought to find traces of these gradual modifications. Thus, between the palæotheria and our present species, we should be able to discover some intermediate forms; and yet no such discovery has ever been made.

Why have not the bowels of the earth preserved the monuments of so strange a genealogy, if it be not because the species of former times were as constant as ours; or, at least, because the catastrophe which destroyed them, had not left them sufficient time for undergoing the variation alleged?

In order to reply to those naturalists who acknowledge that the *varieties* of animals are restrained within certain limits fixed by nature, it would be necessary to examine how far these limits extend. This is a very curious inquiry,—

highly interesting in itself, under a variety of relations, and yet one that has been hitherto very little attended to.

Before entering upon this inquiry, it is proper to define what is meant by a *species*, so that the definition may serve to regulate the employment of the term. A species, therefore, may be defined, as comprehending *the individuals which descend from each other, or from common parents, and those which resemble them as much as they resemble each other.* Thus, we consider as *varieties* of a species, only the races more or less different which may have sprung from it by generation. Our observations, therefore, regarding the differences between the ancestors and descendants, afford us the only certain rule by which we can judge on this subject; all other considerations leading to hypothetical conclusions destitute of proof. Now, considering the *varieties* in this view, we observe that the differences which constitute it, depend upon determinate circumstances, and that their extent increases in proportion to the intensity of these circumstances.

Thus, the most superficial characters are the most variable: the colour depends much upon the light; the thickness of the fur upon the heat; the size, upon the abundance of food. But in a wild animal, even these varieties are greatly limited by the natural habits of the animal itself, which does not voluntarily remove far from the places where it finds, in the necessary degree, all that is requisite, for the support of its species, and does not even extend its haunts to any great distance, unless it also finds all these circumstances conjoined. Thus, although the wolf and the fox inhabit all the climates from the torrid to the frigid zone, we hardly find any other difference among them, in the whole of that vast space, than a little more or a little less beauty in their fur. I have compared skulls of foxes from the northern countries and from Egypt, with those of the foxes of France, and have found no difference but such as might be expected in different individuals. Such of the wild animals as are confined within narrower limits, vary still less, especially those which are carnivorous. The only difference between the hyena of Persia and that of Morocco, consists in a thicker or a thinner mane.

The wild herbivorous animals feel the influence of climate somewhat more extensively, because there is added to it in their case, the influence of the food, which may happen to differ both as to quantity and quality. Thus, the elephants of one forest are often larger than those of another; and their tusks are somewhat longer in places where their food may happen to be more favourable for the production of the matter of ivory. The same may take place with regard to the horns of rein-deer and stags. But let us compare two elephants the most dissimilar, and we shall not discover the slightest difference in the number and articulations of the bones, the structure of the teeth, &c.

Besides, the herbivorous species, in the wild state, seem more restrained from dispersing than the carnivorous animals, because the sort of food which they require, combines with the temperature to prevent them.

Nature also takes care to guard against the alteration of the species, which might result from their mixture, by the mutual aversion with which it has inspired them. It requires all the ingenuity and all the power of man to accomplish these unions, even between species that have the nearest resemblances. And, when the individuals produced by these forced conjunctions are fruitful, which is very seldom the case, their fecundity does not continue beyond a few generations; and would not probably proceed so far, without a continuance of the same cares which excited it at first. Thus, we never see in our woods individuals intermediate between the hare and the rabbit; between the stag and the doe; or between the martin and the pole-cat.

But the power of man changes this order; it discloses all those variations, of which the type of each species is susceptible; and from them derives productions which the species, if left to themselves, would never have yielded.

Here the degree of the variations is still proportional to the intensity of their cause, which is slavery. It is not very high in the semi-domesticated species, such as the cat. A softer fur; more brilliant colours; greater or less size; these form the whole extent of the variations in this species; for the skeleton of an Angora cat differs in no regular and constant circumstance from that of a wild cat.

In the domesticated herbivorous animals, which we transport into all kinds of climates, and subject to all kinds of management, both with regard to labour and nourishment, we certainly obtain greater variations; but still they are all merely superficial. Greater or less size; longer or shorter horns, or even the want of these entirely; a hump of fat, larger or smaller, on the shoulder; these form the differences between the various races of the common ox or bull; and these differences continue long, even in such breeds as have been transported from the countries in which they were produced, when proper care is taken to prevent crossing.

Of this nature are also the innumerable varieties of the common sheep, which consist chiefly in differences of their fleeces, as the wool which they produce is an important object of attention. These varieties, although not quite so perceptible, are yet sufficiently marked among horses. In general, the forms of the bones vary little; their connections and articulations, and the forms of the large grinding teeth, never vary at all.

The small size of the tusks in the domestic hog, compared with the wild boar's, and the junction of its cloven hoofs into one in some races, form the extreme point of the differences which we have produced in the domesticated herbivorous quadrupeds.

The most remarkable effects of the influence of man are manifested in the animal which he has reduced most completely under subjection, the dog,—that species so entirely devoted to ours, that even the individuals of it seem to have sacrificed to us their will, their interest, and inclination. Transported by man into every part of the world, subjected to all the causes capable of influencing their development, regulated in their sexual intercourse by the pleasure of their masters, dogs vary in colour; in the quantity of their hair, which they sometimes even lose altogether, and in its nature; in size, which varies as one to five in the linear dimensions, amounting to more than a hundred fold in bulk; in the form of the ears, nose, and tail; in the proportional length of the legs; in the progressive development of the brain in the domestic varieties, whence results the form of their head, which is sometimes slender, with a lengthened muzzle and flat forehead, and sometimes having a short muzzle and a protuberant forehead; insomuch that the apparent differences between a mastiff and a water-spaniel, and between a greyhound and a pug, are more striking than those that exist between any two species of the same natural genus in a wild state. Finally, and this may be considered as the maximum of variation hitherto known in the animal kingdom, there are races of dogs which have an additional toe on the hind foot, with corresponding tarsal bones; as there are, in the human species, some families that have six fingers on each hand. Yet, in all these varieties, the relations of the bones remain the same, nor does the form of the teeth ever change in any perceptible degree; the only variation in respect to these latter being, that, in some individuals, one additional false grinder appears, sometimes on the one side, and sometimes on the other *.

Animals, therefore, have natural characters, which resist every kind of influence, whether na-

---

* See M. Frederick Cuvier's memoir upon the varieties of dogs, in the Annales du Museum d'Histoire Naturelle, which he drew up at the request of Professor Cuvier, from a series of skeletons of all the varieties of the dog prepared in the Professor's collection.

tural or produced by human interference, and nothing indicates that, with regard to them, time has more effect than climate and domestication.

I am aware that some naturalists lay great stress upon the thousands of ages which they call into action by a dash of the pen; but, in such matters, we can only judge of what a long period of time might produce, by multiplying in idea what a less time produces. With this view, I have endeavoured to collect the most ancient documents relating to the forms of animals; and there are none which equal, either in antiquity or abundance, those that Egypt furnishes. It affords us, not only representations of animals, but even their identical bodies embalmed in its catacombs.

I have examined with the greatest attention the figures of quadrupeds and birds sculptured upon the numerous obelisks brought from Egypt to ancient Rome. All these figures possess, in their general character, which alone could be the object of attention to an artist, a perfect resemblance to the species represented, such as we see them at the present day.

On examining the copies made by Kirker and Zoega, we find that, without preserving every trait of the originals in its perfect purity, they have given figures which are easily recognised. We readily distinguish the ibis, the vulture, the owl, the falcon, the Egyptian goose, the lapwing, the landrail, the aspic, the cerastes, the Egyptian hare with its long ears, and even the hippopotamus; and, among the numerous monuments engraved in the great work on Egypt, we sometimes observe the rarest animals, the algazel, for example, which was not seen in Europe until within these few years *.

My learned colleague, M. Geoffroy Saint-Hilaire, strongly convinced of the importance of this research, carefully collected in the tombs and temples of Upper and Lower Egypt as many mummies of animals as he could. He has brought home cats, ibises, birds of prey, dogs, monkeys, crocodiles, and the head of an ox, in this state; and there is certainly no more difference to be perceived between these mummies and the species of the same kind now alive, than between the human mummies and the skeletons of men of the present day. A difference may, indeed, be found between the mummies of the ibis and the bird which naturalists have hitherto described under that name; but I have cleared up all doubts on

---

* The first figure made of it from nature is in the Description de la Menagerie, a work composed by M. Cuvier. It is seen perfectly represented in the great work on Egypt. —Antiq. t. iv. pl. xlix.

this matter, in a Memoir upon the Ibis, which will be found at the end of this Essay, and in which I have shewn that it is still at the present day the same as it was in the time of the Pharaohs. I am aware that, in these, I only cite the monuments of two or three thousand years; but this is the most remote antiquity to which we can resort in such a case.

There is nothing, therefore, to be derived from all the facts hitherto known, that could, in the slightest degree, give support to the opinion that the new genera which I have discovered or established among the fossil remains of animals, any more than those which have in like manner been discovered or established by other naturalists, the *palæotheria, anoplotheria, megalonyces, mastodonta, pterodactyli, ichthyosauri*, &c. might have been the sources of the present race of animals, which have only differed from them through the influence of time or climate. Even if it should prove true, which I am far from believing to be the case, that the fosil elephants, rhinoceroses, elks, and bears, differ no more from those at present existing, than the present races of dogs differ from one another, this would not furnish a sufficient reason for inferring the general identity of the species, because the races of dogs have been subjected to the influence of domestication, which these other animals neither did nor could experience.

Farther, when I maintain that the rocky beds contain the bones of several genera, and the alluvial strata those of several species which no longer exist, I do not assert that a new creation was required for producing the species existing at the present day. I only say that they did not originally inhabit the places where we find them at present, and that they must have come from some other part of the globe.

Let us suppose, for instance, that a great irruption of the sea were now to cover the continent of New Holland with a coat of sand or other debris; it would bury the carcases of animals belonging to the genera *Kangurus*, *Phascolomys*, *Dasyurus*, *Perameles*, flying phalanger, echidna, and ornithorynchus, and it would entirely destroy the species of all these genera, since none of them exist now in any other country.

Were the same revolution to lay dry the numerous narrow straits which separate New Holland from the continent of Asia, it would open a road to the elephants, rhinoceroses, buffaloes, horses, camels, and tigers, and to all the other Asiatic quadrupeds, which would come to people a land where they had been previously unknown.

Were some future naturalist, after having made himself well acquainted with this new race of animals, to search below the surface on which they live, he would find remains of quite a different nature.

What New Holland would be, under the circumstances which we have supposed, Europe, Siberia, and a large portion of America, now actually are. And, perhaps, when other countries shall have been examined, and New Holland among the rest, it will one day be found that they have experienced similar revolutions, I might almost say, mutual changes of productions. For, if we push the supposition farther, and, after the supply of Asiatic animals to New Holland, admit a second revolution, which destroyed Asia, their original country, those naturalists who might observe them in New Holland, their second country, would be equally at a loss to know whence they had come, as we now are to find out the origin of the races of animals that inhabit our own countries.

I now proceed to apply this manner of reasoning to the human species.

Proofs that there are no Fossil Human Bones.

It is certain that no human bones have yet been found among fossil remains; and this furnishes an additional proof that the fossil races were not mere varieties of known species, since they could not have been subjected to human influence.

When I assert that human bones have never been found among fossil organic remains, (I must be understood to speak of fossils or petrifactions, properly so called), or, in other words, in the regular strata of the surface of the globe; for in peat-bogs *(tourbières)*, and alluvial deposits, as in burying-grounds, human bones might as well be found as bones of horses, or other common species. They might equally be found in fissures of rocks, and in caverns, where they may have been covered over by stalactite; but in the beds which contain the ancient races, among the *palæotheria*, and even among the elephants and rhinoceroses, the smallest portion of a human bone has never been discovered. Many of the labourers in the gypsum quarries about Paris, believe that the bones which occur so abundantly in them, are in a great part human; but I have seen several thousands of these bones, and I may safely affirm that not one of them has ever belonged to our species. I have examined at Pavia the groups of bones brought by Spallanzani from the Island of Cerigo; and, notwithstanding the assertion of that celebrated observer, I equally affirm, that there is not one among them that could be shewn to be human. The *homo diluvii testis* of Scheuchzer has been restored, in my first edition, to its true genus, which is that of the salamanders; and, in a more recent examination of it at Haarlem, allowed me by the politeness of Mr Van Marum, who permitted me to uncover the parts enveloped in the stone, I obtained complete proof of what I had before announced. Among the bones found at Canstadt, the fragment of a jaw, and some articles of human manufacture, were found; but it is known that the ground was dug up without any precaution, and that no notes were taken of the different depths at which each article was discovered. Every where else, the fragments of bone alleged to be human, are found, on examination, to belong to some animal, whether these fragments have been examined themselves, or merely through the medium of figures. Very recently, some were pretended to have been discovered at Marseilles, in a quarry that had been long neglected;* but they have turned out to be impressions of *tuyaux marines.*† Such real human bones as have been exhibited as fossil, belonged to bodies that had fallen into fissures, or had been left in the old galleries of mines, or that had been incrusted; and I extend this assertion even to the human skeletons discovered at Guadaloupe, in a rock formed of fragments of madrepore, thrown up by the sea, and united by water impregnated with calcareous matter.* The human bones found near Kœstriz, and pointed out by M. de Schlotheim, had been announced as taken out of very old beds; but this estimable naturalist is anxious to make known how much this as-

---

* See the Journal de Marseille et des Bouches-du-Rhône, of the 27th Sept. 25th Oct. and 1st Nov. 1820.

† I am confirmed in this opinion by the sketches transmitted to me by M. Cottard, one of the Professors of the College of Marseilles.

---

* These skeletons, more or less mutilated, are found near Port de Moule, on the north-west coast of the mainland of Guadaloupe, in a kind of slope resting against the steep edges of the island. This slope is, in a great measure, covered by the sea at high-water, and is nothing else than a tufa, formed, and daily augmented, by the very small debris of shells and corals, which the waves detach from the rocks, and the accumulated mass of which assumes a great degree of cohesion in the places that are most frequently left dry. We find, on examining them with a lens, that several of these fragments have the same red tint as a part of the corals contained in the reefs of the island. Formations of this kind are common in the whole archipelago of the Antilles, where they are known to the Negroes under the name of *Maçonne-bon-dieu*. Their augmentation is proportioned to the violence of the surge. They have extended the plain of the Cayes to St Domingo, the situation of which has some resemblance to the Plage du Moule, and there are sometimes found in it fragments of earthen vessels, and of other articles of human fabrication, at a depth of twenty feet. A thousand conjectures have been made, and even events imagined, to account for these skeletons of Guadaloupe. But, from all the circumstances of the case, M. Moreau de Jonnès, correspondent of the Academy of Sciences, who has been upon the spot, and to whom I am indebted for the above details, thinks that they are merely bodies of persons that have perished by shipwreck. They were discovered in 1805 by M. Manuel Cortès y Campomanès, at that time a general officer in the service of the colony. General Er-

---

nouf, the governor, caused one to be extracted with much labour, of which the head, and almost the whole superior extremities, were wanting. This had been deposited at Guadaloupe, in the expectation that another and more complete specimen would be procured, in order to send them together to Paris, when the island was taken by the English. Admiral Cochrane having found this skeleton at the head-quarters, sent it to the English Admiralty, who presented it to the British Museum. It is still in that collection, and M. Kœnig, Keeper of the Mineralogical Department, has described it in the Phil. Trans. of 1814, and there I saw it in 1818. M. Kœnig observes, that the stone in which it is imbedded, has not been cut to its present shape, but that it seems to have been simply inserted, in the form of a distinct nodule, into the surrounding mass. The skeleton is so superficial, that its presence must have been perceived by the projection of some of its bones. They still contain some of their animal matter, and the whole of their phosphate of lime. The rock being entirely formed of pieces of corals, and of compact limestone, readily dissolves in nitric acid. M. Kœnig has detected fragments of *Millepora miniacea*, of several madrepores, and of shells, which he compares to *Helix acuta* and *Turbo pica*. This fossil skeleton is represented in Plate I. More recently, General Donzelot has caused another of these skeletons to be extracted, which is now in the Royal Cabinet, and of which a figure is given in Plate II. It is a body which has the knees bent. A small portion of the upper jaw, the left half of the lower, nearly the whole of one side of the trunk and pelvis, and a large portion of the left upper and lower extremities, are what remain of it. The rock which contains it, is evidently sertion is still subject to doubt.[*] The same has been the case with the articles of human fabrication. The pieces of iron found at Montmartre are fragments of the tools which the workmen use for putting in blasts of gunpowder, and which sometimes break in the stone[†].

Yet human bones preserve equally well with those of animals, when placed in the same circumstances. In Egypt, no difference is remarked between the mummies of men and those of quadrupeds. I picked up, from the excavations made some years ago in the ancient church of St Genevieve, human bones that had been interred below the first race, which may even have belonged to some princes of the family of Clovis, and which

---

a travertin, in which are imbedded shells of the neighbouring sea, and land-shells, which are still found alive in the island, namely, the *Bulimus guadalupensis* of Ferussac.

[*] See M. de Schlotheim's Treatise on Petrifactions, Gotha, 1820, p. 57; and his Letter in the Isis of 1820, 8th Number, No. 6. of Supplement.

[†] It is perhaps proper that I take notice of those fragments of sandstone, regarding which some noise was attempted to be made last year (1824), and in which a man and a horse were alleged to have been found petrified. The mere circumstance of its being a man and a horse, with their flesh and skin, that these fragments must have represented, might have enabled every one to perceive that the whole was a mere *lusus naturæ*, and not a true petrifaction.—Note L.

still retained their forms very perfectly *. We do not find in ancient fields of battle that the skeletons of men are more wasted than those of horses, except in so far as they may have been influenced by size; and we find among fossil remains the bones of animals as small as rats, still perfectly preserved.

Every circumstance, therefore, leads to the conclusion, that the human species did not exist in the countries in which the fossil bones have been discovered, at the epoch of the revolutions by which these bones were covered up; for there cannot be a single reason assigned,why men should have entirely escaped from such general catastrophes, or why their remains should not be now found like those of other animals. I do not presume, however, to conclude that man did not exist at all before this epoch. He might then have inhabited some narrow regions, whence he might have repeopled the earth after those terrible events. Perhaps also, the places which he inhabited may have been entirely swallowed up in the abyss, and his bones buried at the bottom of the present seas, with the exception of a small number of individuals, which have continued the species.

---

* Fourcroy has given an analysis of them in the Annales du Museum, vol. x. p. 1.

However this may be, the establishment of man in those countries in which we have said that the fossil remains of land animals are found, that is to say, in the greatest part of Europe, Asia, and America, has necessarily been posterior, not only to the revolutions which have covered up these bones, but also to those which have laid bare the strata containing them, and which are the last that the globe has undergone. Hence it clearly appears, that no argument in favour of the antiquity of the human species in these different countries can be derived either from those bones themselves, or from the more or less considerable masses of rocks or of earthy materials by which they are covered.

Physical Proofs of the Newness of the Present Continents.

On the contrary, by a careful examination of what has taken place on the surface of the globe, since it has been laid dry for the last time, and its continents have assumed their present form, at least in the parts that are somewhat elevated, it may be clearly seen that this last revolution, and consequently the establishment of our existing societies, could not have been very ancient. This result is one of the best established, and, at the same time, one of the least attended to in rational geology; and it is so much the more valuable, that it connects natural and civil history in one uninterrupted series.

When we measure the effects produced in a given time by causes still acting, and compare them with those which the same causes have produced since they have begun to act, we are enabled to determine nearly the instant at which their action commenced; which is necessarily the same as that in which our continents assumed their present form, or that of the last sudden retreat of the waters.

It must, in fact, have been since this last retreat of the waters, that our present steep declivities have begun to disintegrate, and to form heaps of debris at their bases; that our present rivers have begun to flow, and to deposit their alluvial matters; that our present vegetation has begun to extend itself, and to produce soil; that our present cliffs have begun to be corroded by the sea; that our present downs have begun to be thrown up by the wind: just as it must have been since this same epoch, that colonies of men have begun, for the first or second time, to spread themselves, and to form establishments in places fitted by nature for their reception. I do not here take the action of volcanoes into account, not only because of the irregularity of their eruptions, but because we have no proofs of their not having been able to exist under the sea; and because, on that account, they cannot serve us as a measure of the time which has elapsed since its last retreat.

Additions of Land by the Action of Rivers.

MM. Deluc and Dolomieu have most carefully examined the progress of the formation of new ground by means of matters washed down by rivers; and although exceedingly opposed to each other on many points of the Theory of the Earth, they agree in this. These formations augment very rapidly; they must have increased still more rapidly at first, when the mountains furnished more materials to the rivers, and yet their extent is still inconsiderable.

Dolomieu's Memoir respecting Egypt * tends to prove, that the tongue of land on which Alexander caused his city to be built, did not exist in the days of Homer; that they were then able to navigate directly from the island of Pharos into the gulf afterwards called *Lake Mareotis*; and that this gulf was then, as indicated by Menelaus, from fifteen to twenty leagues in length. It had, therefore, only required the nine hundred years that elapsed between the time of Homer and that of Strabo, to bring things to the state in which this latter author describes them, and to reduce the gulf in question to the form of a lake, of six leagues in length. It is more certain, that, since that time, things have changed still more. The sand thrown up by the sea and winds have formed, between the island of Pharos and the site of ancient Alexandria, a tongue of land two hundred fathoms in breadth, upon which the modern city has been built. It has blocked up the nearest mouth of the Nile, and reduced the lake Mareotis to almost nothing; while, during the same period, the alluvial matter carried down by the Nile, has been deposited along the rest of the shore, and has greatly increased its extent.

---

* Journal de Physique, t. xlii, p. 40. *et seq.*

The ancients were not ignorant of these changes. Herodotus says, that the Egyptian priests regarded their country as a gift of the Nile. It is only in a manner, he adds, within a short period, that the Delta has appeared *. Aristotle observes, that Homer speaks of Thebes as if it had been the only great city in Egypt; and nowhere makes mention of Memphis †. The Canopian and Pelusian mouths of the Nile were formerly the principal ones; and the coast extended in a straight line from the one to the

---

* Herod. Euterpe, v. and xxv.

† Arist. Meteor. lib. i. cap. 14.

other; and in this manner it still appears in the charts of Ptolemy. Since then, the water has been directed into the Bolbitian and Phatnitic mouths; and it is at these entrances into the sea that the greatest depositions have been formed, which have given the coast a semicircular outline. The cities of Rosetta and Damieta, which were built upon these mouths, close to the edge of the sea, less than a thousand years ago, are now two leagues distant from it. According to Demaillet*, it would only have required twenty-six years to form a promontory of half a league in extent before Rosetta .

An elevation is produced in the soil of Egypt, at the same time that this extension of its surface takes place, and the bed of the river rises in the same proportion as the adjacent plains, which makes the inundations of every succeeding century pass far beyond the marks which it had left during the preceding ones. According to Herodotus, a period of nine hundred years was sufficient to establish a difference of level amounting to ten or twelve feet. At Elephantia †, the inundation at present exceeds by seven feet the greatest heights which it attained under Septimus Severus, at the commencement of the third century. At Cairo, before it is judged sufficient for the purpose of irrigation, it must exceed, by three feet and a half, the height which was necessary in the ninth century. The ancient monuments of this celebrated land have all their bases more or less buried in the soil. The mud left by the river even covers, to a depth of several feet, the artificial mounds on which the ancient towns were built *.

---

* Demaillet, Description of Egypt, p. 102,-3.

† Herod. Euterpe, xiii.

The delta of the Rhone is not less remarkable for its increase. Astruc gives a detailed account of it in his Natural History of Languedoc; and proves, by a careful comparison of the descriptions of Mela, Strabo and Pliny, with the state of the places as they existed at the commencement of the eighteenth century, taking into account the statements of several writers of the middle age, that the arms of the Rhone have increased three leagues in length in the course of eighteen hundred years; that similar additions of land are made to the west of the Rhone; and that a num-

---

* See M. Girard's Observations on the valley of Egypt; and on the secular increase of the soil which covers it, in the great work upon Egypt, and Mod. Mem. t. ii. p. 343. On this subject we may further observe that Dolomieu, Shaw, and other respectable authors, have estimated these secular elevations much higher than M. Girard. It is to be lamented, that nowhere has it been tried to examine the depth of these deposits over the original soil, or the natural rock.

ber of places, which were situated, six or eight hundred years ago, at the edge of the sea or of large pools, are now several miles distant from the water.

Any one may observe in Holland and Italy, with what rapidity the Rhine, the Po, and the Arno, since they have been confined within dikes, raise their beds, advance their mouths into the sea, forming long promontories at their sides; and judge, from these facts, how small a number of ages was required by these rivers to deposit the low plains which they now traverse.

Many cities, which were flourishing sea-ports at well known periods of history, are now some leagues inland; and several have even been ruined, in consequence of this change of position. The inhabitants of Venice find it exceedingly difficult to preserve the *lagunes*, by which that city is separated from the continent; and notwithstanding all their efforts, it will be inevitably joined to the mainland *.

We know, from the testimony of Strabo, that Ravenna stood among lagunes in the time of Augustus, as Venice does now; but at present Ravenna is a league distant from the shore. Spina had been built by the Greeks at the edge of the sea; yet in Strabo's time it was ninety stadia from it, and is now destroyed. Adria in Lombardy, which gave name to the Adriatic sea, and of which it was, somewhat more than twenty centuries ago, the principal port, is now six leagues distant from it. Fortis has even rendered it probable that, at a more remote period, the Euganian Mountains may have been islands.

---

* See M. Forfait's Memoir on the lagunes of Venice, inserted in the Mém. de la Classe Phys. de l'Institut, t. v. p. 213.

M. de Prony, a learned member of the Institute, and inspector-general of bridges and roads, has communicated to me some observations which are of the greatest importance, as explaining those changes that have taken place along the shores of the Adriatic *. Having been directed by government to investigate the remedies that might be applied to the devastations occasioned by the floods of the Po, he ascertained that this river, since the period when it was shut in by dikes, has so greatly raised the level of its bottom, that the surface of its waters is now higher than the roofs of the houses in Ferrara. At the same time, its alluvial depositions have advanced so rapidly into the sea, that, by comparing old charts with the present state, the shore is found to have gained more than six thousand fathoms since 1604, giving an average of a hundred and fifty or a hundred and

---

* Note M.

eighty, and in some places two hundred feet yearly. The Adige and the Po, are at the present day higher than the whole tract of land that lies between them; and it is only by opening new channels for them in the low grounds, which they have formerly deposited, that the disasters which they now threaten may be averted.

The same causes have produced the same effects along the branches of the Rhine and the Meuse; and thus the richest districts of Holland have continually the frightful view of their rivers held up by embankments at a height of from twenty to thirty feet above the level of the land.

M. Wiebeking, director of bridges and highways in the kingdom of Bavaria, has written a memoir upon this subject, so important as to be worthy of being properly understood, both by the people and the government, in all countries where these changes take place. In this memoir, he shews that the property of raising the level of their beds is common in a greater or less degree to all rivers.

The additions of land that have been made along the shores of the North Sea, have not been less rapid in their progress than in Italy. They can be easily traced in Friesland and in the country of Groningen, where the epoch of the first dikes, constructed by the Spanish governor Gaspar Roblès, is well known to have been in 1570. An hundred years afterwards, land had already been gained, in some places, to the extent of three quarters of a league beyond these dikes; and even the city of Groningen, partly built upon the old land, on a limestone which does not belong to the present sea, and in which the same shells are found as in the coarse limestone of the neighbourhood of Paris, is only six leagues from the sea. Having been upon the spot, I am enabled to adduce my own testimony in confirmation of facts already well known, and which have been so well stated by M. Deluc *. The same phenomenon may be as distinctly observed along the coasts of East Friesland, and the countries of Bremen and Holstein, as the period at which the new grounds were inclosed for the first time is known, and the extent that has been gained since can be measured.

This new alluvial land, formed by the rivers and the sea, is of astonishing fertility, and is so much the more valuable, as the ancient soil of these countries, being covered with heaths and peat-mosses, is almost everywhere unfit for cultivation. The alluvial lands alone produce subsistence for the many populous cities that have been built along these coasts, since the middle age, and which perhaps would not have attained their present flourishing condition, without the aid of the rich deposits

---

* In various parts of the two last volumes of his Letters to the Queen of England.

which the rivers had prepared for them, and which they are continually augmenting.

If the size which Herodotus attributes to the Sea of Asoph, which he makes equal to the Euxine *, had been less vaguely indicated, and if we knew precisely what he meant by the Gerrhus †, we should there find strong additional proofs of the changes produced by rivers, and the rapidity with which they are made; for the alluvial depositions of rivers alone have, since the time of Herodotus, that is to say, in the course of two thousand and two or three hundred years, reduced the Sea of Asoph ‡ to its present comparatively small size, shut up the course of the Gerrhus, or that branch of the Dnieper which had formerly joined the Hypacyris, and discharged its waters along with that river into the gulf called Carcinites,

---

* Melpom. lxxxvi.

† Ibid. lvi.

‡ This supposed diminution of the Black Sea and Sea of Asoph, has also been attributed to the rupture of the Bosphorus, which had taken place at the pretended period of the deluge of Deucalion; and yet, in order to establish the fact itself, recourse is had to successive diminutions of the extent attributed to these seas by Herodotus, Strabo, and others. But it is very obvious, that, if this diminution had arisen from the rupture of the Bosphorus, it would necessarily have been completed long before the time of Herodotus, and even at the period at which Deucalion is supposed to have lived.

now the Olu-Degnitz, and reduced the Hypacyris itself to almost nothing*. We should possess proofs no less strong of the same kind, could we be certain that the Oxus or Sihoun, which at present discharges itself into the lake Aral, formerly reached the Caspian Sea. But we are in possession of facts sufficiently conclusive on the point in question, without adducing such as are doubtful, and without being exposed to the necessity of making the ignorance of the ancients in geography the basis of our physical propositions.†

---

* See the Geography of Herodotus by M. Rennel, p. 56. *et seq.*; and the Physical Geography of the Black Sea, &c. by M. Dureau de Lamalle. There is only at present the small river of Kamennoipost, that could represent the Gerrhus and Hypacyris, such as they are described by Herodotus.

M. Dureau, p. 170, supposes Herodotus to have made the Borysthenes and Hypanis discharge themselves into *the* Palus Mæotis; but Herodotus (in Melpom. liii.) only says that these two rivers fall together into the same lake, that is, into the Liman, as at the present day. Herodotus does not carry the Gerrhus and Hypacyris any farther.

† For example, M. Dureau de Lamalle, in his Physical Geography of the Black Sea, quotes Aristotle (Meteor. lib. i. cap. 13.) as "apprising us, that, in his time, there still existed several ancient periods and peripli, attesting that there had been a canal leading from the Caspian Sea into the Palus Mæotis." Now, Aristotle's words at the place mentioned (Duval's edition, i. 545. B.) are merely these: "From the Paropamisus, descend, among other rivers, the Bactrus, the Choaspes, and

Progress of the Downs.

THE downs or hillocks of sand which the sea throws up on low coasts, when its bottom is sandy, have already been mentioned. Wherever human industry has not succeeded in fixing these downs, they advance as irresistibly upon the land as the alluvial depositions of the rivers advance into the sea. In their progress inland, they push before them the large pools formed by the rain which falls upon the neighbouring grounds, and whose communication with the sea is intercepted by them. In many places they proceed with a frightful rapidity, overwhelming forests, buildings, and cultivated fields. Those upon the coast of the Bay of Biscay * have already overwhelmed a great number of villages mentioned in the records of the

---

the Araxis, from which the Tanais, which is a branch of it, takes its origin, into the Palus Mæotis." Who does not see that this nonsense, which is neither founded upon peripli nor periods, is nothing else than the strange idea of Alexander's soldiers, who took the Jaxartes or Tanais of the Transoxian for the Don or Tanais of Scythia? Arrian and Pliny distinguish these two rivers from each other, but the distinction does not appear to have been made in the time of Aristotle. How, then, could such geographers as these furnish us with geological documents?

* See the Report upon the Downs of the Gulf of Gascony (or Bay of Biscay) by M. Tassin.—Mont. de-Marsan, an x.

middle age; and at this moment, in the single Department of the *Landes*, they threaten ten with inevitable destruction. One of these villages, named Mimisan, has been struggling against them these twenty years, with the melancholy prospect of a sand-hill of more than sixty feet perpendicular height visibly approaching it.

In 1802, the pent up pools overwhelmed five fine farming establishments at the village of St Julian [*]. They have long covered up an ancient Roman road leading from Bourdeaux to Bayonne, and which could still be seen forty years ago, when the waters were low [†]. The Adour, which is known to have formerly passed Old Boucaut, to join the sea at Cape Breton, is now turned to the distance of more than two thousand yards.

The late M. Bremontier, inspector of bridges and highways, who conducted extensive operations upon these downs, estimated their progress at sixty feet yearly, and in some places at seventy-two feet. According to this calculation, it will only require two thousand years to enable them to reach Bourdeaux; and, from their present extent, it must have been somewhat more than four thousand years since they began to be formed [*].

---

[*] Memoir on the means of fixing Downs, by M. Bremontier.

[†] Report of M. Tassin, loc. cit.

The overwhelming of the cultivated lands of Egypt, by the sterile lands of Libya, which are thrown upon them by the west wind, is a phenomenon of the same nature with the downs. These sands have destroyed a number of cities and villages, whose ruins are still to be seen; and this has happened since the conquest of the country by the Mahometans, for the summits of the minarets of some mosques are seen projecting beyond the sand [†]. With a progress so rapid, they would, without doubt, have filled up the narrow parts of the valley, if so many ages had elapsed since they began to be thrown into it [‡]; and there would no longer remain any thing between the Libyan chain and the Nile. Here, then, we have another natural chronometer, of which it would be as easy as interesting to obtain the measure.

Peat-Mosses and Slips.

THE turbaries, or peat-mosses, which have been found so generally in the northern parts of Europe, by the accumulation of the remains of

---

[*] See M. Bremontier's Memoir.

[†] Denon, Voyage en Egypte.

[‡] We might cite in confirmation all the travellers who have visited the western border of Egypt.

sphagna and other aquatic mosses, also afford a measure of time. They increase in height in proportions which are determinate with regard to each place. They thus envelope the small knolls of the lands on which they are formed; and several of these knolls have been covered over within the memory of man. In other places the peat-mosses descend along the valleys, advancing like glaciers, but differing from them in this respect, that, while the glaciers melt at their lower part, the progress of the peat is impeded by nothing. By sounding their depth down to the solid ground, we may estimate their age; and we find, with regard to these peat-mosses, as with regard to the downs, that they cannot have derived their origin from an indefinitely remote period. The same observation may be made with regard to the slips or fallings, which take place with wonderful rapidity at the foot of all steep rocks, and which are still very far from having covered them. But as no precise measures have hitherto been applied to these two agents, we shall not insist upon them at greater length *.

---

* These phenomena are very well treated of in M. Deluc's Letters to the Queen of England, in the parts where he describes the peat-moses of Westphalia; and in his Letters to Lametherie, inserted in the Journal de Physique for 1791, &c. as well as in those which he has addressed to Blumenbach. We may refer also to the very interesting details which

From all that has been said, it may be seen that nature uniformly speaks the same language, everywhere informing us that the present order of things cannot have commenced at a very remote period. And, what is very remarkable, mankind everywhere speaks as nature, whether we consult the received traditions of the various nations, or examine their moral and political state, and the intellectual attainments which they had made at the period when their authentic records commence.

The History of Nations confirms the Newness of the Continents.

In fact, although, at the first glance, the traditions of some ancient nations, which extend their origin to so many thousands of ages, appear strongly to contradict this newness of the world, as it exists at present; yet when we examine these traditions more carefully, we soon perceive that they are not sufficiently authenticated. We are, on the contrary, quickly convinced, that true history, deserving that name, and all that has been

---

are given in note F, respecting the islands of the west coast of the Duchy of Sleswick, and the manner in which they have been joined, whether to one another, or to the continent, by alluvial depositions and peat-mosses, as well as respecting the irruptions of the sea which from time to time have destroyed or separated some of their parts.

preserved of positive documents regarding the first establishment of nations, confirm what has been announced by the natural monuments already mentioned.

The chronology of none of the western nations can be traced in a continuous line farther back than 3000 years. None of them afford us, previous to that period, nor even two or three centuries after, a series of facts connected with any degree of probability. The north of Europe possesses no authentic records which bear a remoter date than that of its conversion to Christianity. The history of Spain, of Gaul, and of England, commences only at the period when these countries were conquered by the Romans; that of northern Italy is, at the present day, almost unknown. The Greeks acknowledge that they did not possess the art of writing, until it was taught them by the Phenicians, fifteen or sixteen centuries before the Christian era; even for a long time after, their history is full of fables; and they do not assign a more remote date than 300 years farther back, to their uniting into distinct tribes. Of the history of Western Asia, we have only a few contradictory extracts, which do not, with any connection, give a greater antiquity than twenty-five centuries*; and even if we admit the few historical details which refer to more remote periods, it can scarcely be extended to forty *.

---

* The period of Cyrus, about 650 years before the Christian era.

Herodotus, the first profane historian whose works have been transmitted to us, has not a greater antiquity than 2300 years †. The historians, prior to him, whom he may have consulted, do not date a century before him ‡. We may even judge of what they were by the extravagances handed down to us, extracted from the works of *Aristæus* of Proconnesus, and some others. Before them we have only poets; and *Homer*, the most ancient that we possess, Homer the immortal master and model of all the West, flourished only twenty-seven or twenty-eight centuries before the present time.

When these first historians speak of ancient events, whether occurring in their own nation, or in neighbouring countries, they only cite oral traditions, and not public works. It was not until a long time after them, that pretended extracts were given from the Egyptian, Phenician, and Babylonian annals. *Berosus* wrote only in the reign of Seleucus Nicanor; *Hieronymus* in that of Antiochus Soter, and *Manetho* under Ptolemy Philadelphus; the whole three having flourished only in the third century before the Christian era. That *Sanconiatho* was an author real or supposed, was not known till Philo of Byblos had published a translation of his work in the reign of Adrian, in the second century before Christ; and, when he did become known, there was nothing found in his account of the early ages, as in those of all the authors of this kind, but a puerile theogony, or metaphysical doctrines, so disguised under the form of allegory as to be unintelligible

---

* The period of Ninus, about 2348 years before Christ, according to Ctesias, and those who have followed him; but only 1250, according to Volney, after Herodotus.

† Herodotus lived 440 years before Christ.

‡ Cadmus, Pherecydes, Aristæus of Proconnesus, Acusilaus, Hecatæus of Miletum, Charon of Lampsacus, &c. See Vossius, Histor. Græc. lib. i., and especially his fourth book.

One nation alone has preserved annals written in prose before the period of Cyrus, namely, the Jewish people. The part of the Old Testament which is known by the name of the *Pentateuch*, has existed in its present form, at least since the separation of the ten tribes under Jeroboam, since it was received as authentic by the Samaritans equally as the Jews, which assures us that its actual antiquity is upwards of 2800 years. Besides this, we have no reason to doubt the book of Genesis having been composed by Moses himself, which gives it an antiquity of 500 years more, or of thirty-three centuries; and it is only necessary to read it, to perceive that it has in part been composed of fragments of previously existing works. We cannot, therefore, hesitate to admit, that this is the most ancient writing which has been transmitted to modern times in the West*.

Now, this work, and all those which have been composed since, whatever strangers their authors might be to Moses and his people, speak of the nations on the shores of the Mediterranean as of recent origin; they represent them as still in a half savage state some ages before. And, further, they all speak of a general catastrophe, an irruption of the waters, which occasioned an almost total regeneration of the human race; and to this epoch they do not assign a very remote antiquity. Those texts of the Pentateuch, which extend this epoch the longest, do not place it farther back than twenty centuries before Moses, and hence not more than 5400 years before the present day†.

In the poetical traditions of the Greeks, from which is derived the whole of our profane history with reference to those remote ages, there is nothing which contradicts the Jewish annals. On the ance to any opinion whatever, regarding the precise dates of Inachus [*] or Ogyges [†]; but, if any thing ought to surprise us, it is this,—that an infinitely more remote antiquity had not been assigned to those personages. It is impossible that there has not been in this case some effect of the influence of received traditions, from which the inventors of fables were not able to free themselves. One of the dates assigned to the deluge of Ogyges, even agrees so much with one of those which have been attributed to the deluge of Noah, that it is almost impossible it should not have been derived from some source, where this latter deluge had been the one intended to be spoken of [‡].

---

* Note N.

† The Septuagint, 5345 years; the Samaritan text, 4869; the Hebrew text, 4174.

---

[*] 1856 or 1823 years before Christ, or other dates still, but always about 350 years before the principal Phenician or Egyptian colonies.

[†] The common date of Ogyges, according to Acusilaus, followed by Eusebius, is 1796 years before Christ, consequently several years after Inachus.

[‡] Varro places the deluge of Ogyges, which he calls the *first deluge*, 400 years before Inachus, and consequently 1600 years before the first Olympiad. This would refer it to a period of 2376 years before Christ; and the deluge of Noah, according to the Hebrew text, is 2349, there being only 27 years of difference. This testimony of Varro is

As to Deucalion, whether this prince be regarded as a real or fictitious personage, however little we enter into the manner in which his deluge has been introduced into the poems of the Greeks, and the various details with which it becomes successively enriched, we perceive that it was nothing else than a tradition of the great cataclysm, altered and placed by the Hellenians in the period which they also assigned to Deucalion, because he was regarded as the founder of their nation, and because his history is confounded with that of all the chiefs of the renewed nations*.

---

mentioned by Censorinus, *De Die Natali*, cap. xxi. In reality, Censorinus wrote only 238 years after Christ; and, it appears, from Julius Africanus, *ap. Euseb.* Præp. cv. that Acusilaus, the first author who placed a deluge in the reign of Ogyges, made this prince cotemporary with Phoronæus, which would have brought him very near the first Olympiad. Julius Africanus makes only an interval of 1020 years between the two epochs; and there is even a passage in Censorinus conformable to this opinion. Some also read *erogitium* in place of *ogygium*, in the passage of Varro, which we have quoted above from Censorinus. But what would this be but an Erogitian Cataclysm, of which nobody has ever heard?

* Neither Homer nor Hesiod knew any thing of the deluge of Deucalion, any more than that of Ogyges. The first author, whose works are extant, by whom mention is made of the former, is Pindar (Od. Olymp. ix.) He speaks of Deuca-

Each of the different colonies of Greece, that had preserved isolated traditions, commenced

---

lion as landing upon Parnassus, establishing himself in the city of Protogene (first growth or birth), and re-creating his people from stones; in a word, he relates, but confining it to a single nation only, the fable afterwards generalized by Ovid, and applied to the whole human race. The first historians who wrote after Pindar, namely, Herodotus, Thucydides, and Xenophon, make no mention of any deluge, whether of the time of Ogyges, or that of Deucalion, although they speak of the latter as one of the first kings of the Hellenes.

Plato, in his Timæus, says only a few words of the deluge, as well as of Deucalion and Pyrrha, in order to commence the recital of the great catastrophe, which, according to the priests of Sais, destroyed the Atlantis; but, in these few words, he speaks of the deluge in the singular number, as if it had been the only one. He even expressly mentions farther on, that the Greeks knew only one. He places the name of Deucalion immediately after that of Phoroneus, the first of the human race, without making mention of Ogyges. Thus, with him, it is still a general event, a true universal deluge, and the only one which had happened. He regards it, therefore, as identical with that of Ogyges.

Aristotle (Meteor. i. 14.) seems to be the first who considered this deluge only as a local inundation, which he places near Dodona and the river Achelous, but near the Achelous and Dodona of Thessaly. Apollodorus (Bibl. i. § 7.) restores to the deluge of Deucalion all its grandeur and mythological character. According to him, it took place at the period when the age of brass was passing into the age of iron. Deucalion is the son of Titan them with a particular deluge of its own, because some remembrance of the general deluge common

---

Prometheus, the fabricator of man; he forms anew the human race of stones; and yet Atlas, his uncle, Phoroneus, who lived before him, and several other personages anterior to him, preserve a lengthened posterity.

In proportion as we advance toward authors who approach nearer our own times, we find circumstances of detail added, which more resemble those related by Moses. Thus Apollodorus gives Deucalion a great chest as a means of safety; Plutarch speaks of the pigeons by which he sought to find out whether the waters had retired; and Lucian, of the animals of every kind which he had taken with him, &c.

With regard to the blending of traditions and hypotheses, by which it has recently been tried to infer the conclusion, that the rupture of the Thracian Bosphorus was the cause of Deucalion's deluge, and even of the opening of the pillars of Hercules, by making the waters of the Euxine Sea discharge themselves into the Archipelago, supposing them to have been much higher and more extended than they have been since that event, it is not necessary for us to treat of it in detail, since it has been determined by the observations of M. Olivier, that if the Black Sea had been as high as it is imagined to have been, it would have found several passages for its waters, by hills and plains less elevated than the present banks of the Bosphorus; and by those of the Count Andreossy, that had it one day fallen suddenly in the manner of a cascade by this new passage, the small quantity of water that could have flowed at once through so narrow an aperture, would not only be diffused over the immense extent of the Mediterranean, without occasioning a tide of a few fathoms, but that to all the nations, was preserved among each of the tribes; and, when it was afterwards attempted to reduce these various traditions to a common chronology, different events were imagined to have been recorded, from the circumstance that dates, in reality uncertain, or perhaps altogether false, although considered as authentic in the countries where they originated, were not found to agree with each other. Thus, in the same manner that the Hellenes had a deluge of Deucalion, because they regarded him as the founder of their nation, the Autochtones of Attica had one of Ogyges, because it was with him that their history commenced. The Pelasgi of Arcadia had that which, according to later authors, compelled Dardanus to retire towards the Hellespont.* The island of Samothracia, one of those in which a succession of priests had been more anciently established, together with a regular worship and connected traditions, had also a de-

---

the mere natural inclination necessary for the flowing of the waters, would have reduced to nothing their excess of height above the shores of Attica.

See further on this subject the note that I have published at the head of the third volume of Ovid, of M. Lemaire's collection.

* Dionysius of Halicarnassus, Antiq. Rom. lib. i. cap. lxi.

luge, which passed for the most ancient of all[*], and which was attributed to the bursting of the Bosphorus and the Hellespont. Some idea of a similar event was preserved in Asia Minor[†], and in Syria[‡], and to this the Greeks would afterwards naturally attach the name of Deucalion[||].

But none of these traditions assign a very reremote antiquity to this cataclysm; and there is none of them that does not admit of explanation, in so far as its date and other circumstances are concerned, from the variations to which narratives, that are not fixed by writing, must be continually liable.

The very remote Antiquity attributed to certain Nations is not supported by History.

Those who would attribute to the continents and the establishment of nations, a very remote antiquity, are therefore obliged to have recourse to the Indians, Chaldeans, and Egyptians, three nations, in fact, which appear to have been the most anciently civilized of the Caucasian Race, and having a remarkable similarity, not only in their temperament, and in the climate and nature of the countries which they occupied, but also in their political and religious constitution, but whose testimony this almost identical constitution ought to render equally suspected *.

---

[*] Diodorus Siculus, lib. v. cap. xlvii.

[†] Stephen of Byzantium, under the word Iconium;—Zenodotus, Prov. cent. vi. No. 10.;—and Suidas, *voce* Nannacus.

[‡] Lucian, De Deâ Syrâ.

[||] Arnobius, Contra Gênt. lib. v. p. m. 158, even speaks of a rock in Phrygia, from which it was pretended that Deucalion and Pyrrha had taken their stones.

These three nations agreed in having each a hereditary caste, to which the care of religion, laws, and science, was exclusively consigned. In all of them, this caste had its allegorical language and secret doctrines; and in all it reserved to itself the privilege of reading and explaining the sacred books, the whole doctrines of which had been revealed by the gods themselves.

We can easily conceive what history would necessarily come to in such hands; but, without having recourse to any great efforts of reason, we may learn it from the fact itself, by examining what it has come to in the only one of these

---

* This mutual resemblance in their institutions is carried to such an extent as to make it very natural to suppose that these nations had a common origin. It should not be forgotten, that many ancient authors thought that the Egyptian institutions came from Ethiopia; and that Syncellus, p. 151. says positively that the Ethiopians came from the banks of the Indus in the time of King Amenophtis.

three nations which still exists, namely, the Indians.

The truth is, that history does not exist at all among them. In the midst of that infinity of books on mystical theology and abstract metaphysics which the Brahmins possess, and many of which have been made known to us by the ingenious perseverance of the English, we find no connected account of the origin of their nation, or of the vicissitudes of their society. They even pretend that their religion prohibits them from recording the events of the present time, their age of misfortune [*].

According to the Vedas, the first revealed works, on which are founded the whole religious opinions of the Hindoos, the literature of this people, like that of the Greeks, had its origin at two great epochs; the Ramaian and the Mahabarat,—a thousand times more monstrous in their wonders than the Iliad and Odyssey, but in which we also perceive some traces of a metaphysical doctrine of that description generally termed sublime. The other poems, which, together with the two mentioned, compose the great body of the Pouranas, are nothing else than metrical legends or romances, written at different periods, and by different authors, and not less extravagant in their fictions than the great poems. It has been imagined that, in some of these writings, events and names of men bearing some resemblance to those spoken of by the Greeks and Latins, might be discovered; and it is chiefly from these resemblances of names that Mr Wilfort has attempted to extract from the Pouranas a kind of concordance with our ancient chronology of the west; a concordance which, in every line, betrays the hypothetical nature of its basis, and which, moreover, can only be admitted by absolutely rejecting the dates given in the Pouranas themselves [*].

---

[*] See Polier. Mythology of the Hindoos, vol. i. p. 89, 91.

The list of kings which the Indian pundits or doctors pretend to have compiled according to these Pouranas, are nothing but mere catalogues without any details, or adorned with absurd ones, like those of the Chaldeans and Egyptians, and like those which Trithemus and Saxo Grammaticus have made up for the northern nations [†].

---

[*] See the elaborate Memoir of Mr Wilfort, on the chronology of the kings of Magadha, and the Indian emperors, and on the epochs of Vicramaditya or Bikermadjit, and Salivahanna, in the Calcutta Memoirs, vol. ix. p. 82. 8vo. edit.

[†] See Sir William Jones on the chronology of the Hindoos, Calcutta Memoirs, vol. ii. p. 111. See also Wilfort

These lists are far from corresponding; none of them supposes a history, or registers, or records; the very basis on which they rest may have been purely imagined by the poets from whose works they have been extracted. One of the pundits who furnished Mr Wilfort with them, acknowledged that he had arbitrarily filled up the spaces between the celebrated kings with imaginary names [*], and avowed that his predecessors had done the same. If this be true of the lists obtained by the English at the present day, how should it not be so of those given by Abou-Fazel, as extracts from the annals of Cachmere [†], and which, besides, full of fables as they are, do not extend farther back than 4300 years, of which more than 1200 are occupied with names of princes whose reigns, in as far as regards their duration, remain undetermined.

Even the era, accordingly, from which the Indians count their years at the present day, which commences fifty-seven years before Christ, and

---

on the same subject, Ibid. vol. v. p. 241. and the lists which he gives in his essay cited above, vol. ix. p. 116.

[*] Wilfort, Calcutta Mem. 8vo. vol. ix. p. 133.

[†] In the Ayeen-Acbery, vol. ii. p. 138. of the English transl. See also Heeren, Commerce of the Ancients, vol. i. part ii. p. 329.

which bears the name of a prince called *Vicramaditjia*, or *Bickermadjit*, bears it only by a sort of convention; for we find, according to the synchronisms attributed to Vicramaditjia, that there may have been at least three, and perhaps so many as eight or nine, princes of this name, who have all similar legends, and who have all waged war with a prince named *Saliwahanna*; and, further, we cannot well make out whether this period, the fifty-seventh year before the Christian era, is that of the birth, reign, or death of the hero whose name it bears.*

Lastly, the most authentic books of the Indians, contradict, by intrinsic and very obvious characters, the antiquity attributed to them by the pundits. Their *vedas*, or sacred books, alleged by them to have been revealed by Brama himself from the beginning of the world, and arranged by *Viasa* (a name which signifies nothing else than collector), at the commencement of the present age, if we judge of them by the calendar which is found annexed, and to which they refer, as well as by the position of the colures indicated by this calendar, may extend to

---

* See Bentley, on the Astronomical Systems of the Hindoos, and their Connection with History; Calcutta Memoirs, vol. viii. p. 243. of the 8vo edition.

3200 years, or about the epoch of Moses.* Nay, perhaps those who give credit to the assertion of Megasthenes†, that in his time the Indians were not acquainted with the art of writing, who reflect that none of the ancients has made mention of their superb temples, those immense pagodas, the remarkable monuments of the religion of the Bramins, and who are aware that the epochs of their astronomical tables have been calculated backwards, and ill-calculated, and that their treatises of astronomy are modern and antedated, will be inclined still farther to reduce the pretended antiquity of the Vedas.

Yet even in the midst of all the Brahminical fictions, circumstances occur, whose agreement with the result of the historical monuments of more western countries cannot but astonish us. Thus, their mythology consecrates the successive devastations which the surface of the globe has already undergone, or is yet destined to undergo; and it is only to a period somewhat less than 5000 years, that they refer the last catastrophe.‡

---

* See Mr Colebrooke's Memoir on the Vedas, Calcutta Memoirs, vol. viii. p. 493. 8vo edition.

† Megasthenes apud Strabonem, lib. xv. p. 709. Almel.

‡ The epoch which gave birth to the present age, *Caliyug* (the earthen age,) 4927 years before the present day, or 3200 years before Christ. See Legentil, Voyage

One of these revolutions, which is in reality placed much farther from us, is described in terms nearly corresponding with those of Moses *. Mr Wilfort even assures us, that, in another event of the same mythology, a conspicuous place is held by a personage who resembles Deucalion, in his origin, name, and adventures, and even in the name and adventures of his father †. It is a cir-

---

aux Indes, t. i. p. 253.;—Bentley, Calcutta Memoirs, vol. viii. of the 8vo edition, p. 212. This period is only fifty-nine years farther back than the deluge of Noah, according to the Samaritan text.

* The person named Satyavrata plays the same part as Noah, by saving himself with fourteen saints. See Sir W. Jones, Calcutta Memoirs, vol. i. p. 230. 8vo edition;—also in the Bagvadam, or Bagavata, translated by Fouché d'Obsonville, p. 212.

† Cala-Javana, or, in common language, Cal-Yun, to whom his partisans might have given the epithet, *deva*, *deo*, (dieu, god), having attacked Chrishna (the Indian Apollo), at the head of the northern nations (the Scythians, of whom was Deucalion, according to Lucian), was repulsed by fire and water. His father Garga had for one of his surnames *Pramathesa* (Prometheus); and, according to another legend, he was devoured by the eagle Garuda. These particulars have been extracted by Mr Wilfort (in his Memoir upon Mount Caucasus, Calcutta Memoirs, vol. vi. p. 507, 8vo edition), from the sanscrit drama, entitled Hari-Vansa. Mr Charles Ritter, in his Vestibule of the History of Europe before Herodotus, concludes that the whole fable of Deucalion was of foreign origin, and had been brought into

cumstance equally worthy of remark, that, in the lists of their kings, imperfect and unauthentic as they are, they date the commencement of their first human sovereigns (those of the race of the sun and moon), at an epoch which is nearly the same as that from which Ctesias, in his singularly constructed list, commences the reign of his Assyrian kings *.

This deplorable state of historical knowledge was necessarily the result of the system of a people, among whom the exclusive privilege of writing, of preserving, and of explaining the books, was given to the hereditary priests of a religion monstrous in its ritual, and cruel in its maxims. Some legend made up for the purpose of establishing a place of pilgrimage, inventions adapted to impress more deeply a respect for their

---

Greece along with the other legends of that part of the Grecian worship which had come from the north, and which had preceded the Egyptian and Phenician colonies. But if it be true that the constellations of the Indian sphere have also names of persons celebrated in Greece, that Andromeda and Cepheus are represented under the names of *Antarmadia* and *Capiia,* &c. we should perhaps be induced to draw, with Mr Wilfort, a conclusion quite the reverse. Unfortunately the authenticity of the documents referred to by this writer has been doubted among the learned.

* About 4000 years before the present time. See Bentley, Calcutta Memoirs, vol. viii. p. 226. of the 8vo edition, Note.

caste, must have interested these priests more than any historical truths. Of the sciences, they might have cultivated astronomy, which would give them credit as astrologers; mechanics, which would assist them in raising their monuments, those signs of their power, and objects of the superstitious veneration of the people; geometry, the basis of astronomy, as well as of mechanics, and an important auxiliary to agriculture in those vast plains of alluvial formation, which could only be rendered healthy and fertile by the aid of numerous canals. They might have encouraged the mechanical or chemical arts, which supported their commerce, and contributed to their luxury, and the magnificence of their temples. But history, which informs men of their mutual relations, would be regarded by them with dread.

What we see in India, we might therefore expect to find in general, wherever sacerdotal races, constituted like those of the Brahmins, and established in similar countries, assumed the same empire over the mass of the people. The same causes produce the same effects; and, in fact, we have only to glance over the fragments of Egyptian and Chaldean traditions which have been preserved, to be convinced that there is no more historical authenticity in them than in those of the Indians.

In order to judge of the nature of the chronicles which the Egyptian priests pretended to possess, it is only necessary to review the extracts which have been given by themselves at different periods, and to different individuals.

Those of *Sais,* for example, informed Solon, about 550 years before Christ, that, as Egypt was not subject to deluges, they had preserved not only their own annals, but those of other nations also; that the cities of Athens and Sais had been built by Minerva, the former 9000 years before, the latter only 8000; and to these dates they added the well known fables respecting the Atlantes, and the resistance which the ancient Athenians opposed to their conquests, together with the whole romantic description of the Atlantis*, a description in which we find events and genealogies similar to those of all mythological romances.

A century later, about 450 years before Christ, the priests of Memphis gave entirely different accounts to Herodotus†. Menes, the first king of Egypt, according to them, had built Memphis, and inclosed the Nile within dikes, as if it were possible that the first king of a country could perform operations of this kind. Between this prince and Mœris, who, according to them, reigned 900 years before the period at which this account was given (1350 years before Christ), they had a succession of three hundred and thirty other kings.

---

* See Plato's Timæus and Critias.

† Euterpe, chap. xcix. et seq.

After these kings came Sesostris, who extended his conquests as far as Colchis*; and altogether, there were, to the time of Sethos, three hundred and forty-one kings, and three hundred and forty-one chief priests, in three hundred and forty-one generations, during a space of 11,340 years. And, in this interval, as if to insure the authenticity of their chronology, these priests asserted that the sun had risen twice where he sets, without any change having taken place in the climate or productions of the country, and without any of the gods having at that time, or before, made their appearance and reigned in Egypt.

---

* Herodotus thought he had discovered relations of figure and colour between the Colchians and Egyptians; but it is infinitely more probable that those dark-coloured Colchians of which he speaks, were an Indian colony, attracted by the commerce anciently established between India and Europe, by the Oxus, the Caspian Sea, and the Phasis. See Ritter, Vestibule of Ancient History before Herodotus, chap. i.

To this fable, which, despite of all the pretended explanations that have been given of it, evinces so gross an ignorance of astronomy, they added, regarding Sesostris, Phero, Helenius, and Rhampsinitus, the kings who built the pyramids, and an Ethiopian conqueror named *Sabacos*, a set of tales equally absurd.

The priests of Thebes did better: they shewed Herodotus, and they had before shewn to Hecatæus, three hundred and forty-five colossal figures of wood, which represented three hundred and forty-five high priests, who had succeeded to each other from father to son, all men, all born the one of the other, but who had been preceded by gods *. Other Egyptians told him that they had exact registers, not only of the reign of men, but also of that of gods. They reckoned 17,000 years from Hercules to Amases, and 15,000 from Bacchus. Pan had even been prior to Hercules †. These people evidently took for history some allegories relating to pantheistic metaphysics, which formed, unknown to them, the basis of their mythology.

---

* Euterpe, chap. cxliii.

† Ibid. cxliv.

It is only from the time of Sethos that Herodotus commences the part of his history which is somewhat rational; and it is worthy of remark, that this part begins with an event which agrees with the Hebrew annals, the destruction of the army of the King of Assyria, *Sennacherib* [*]; and this agreement continues under Necho [†], and under Hophra or Apries.

Two centuries after Herodotus (about 260 years before Christ) Ptolemy Philadelphus, a prince of a foreign race, wished to become acquainted with the history of the country which events had called him to govern. A priest, called Manetho, was employed to write it for him. It was not from registers or archives that he pretended to compile this work, but from the sacred books of Agathodæmon, the son of the second Hermes, and the father of Tat, who had copied it upon pillars erected before the flood by Tot or the first Hermes, in the Seriadic land [‡]. And this second Hermes, this Agathodæmon, this Tat, are personages of whom nothing had ever been said before, any more than of the Seriadic land, or of its pillars. The deluge itself was an event entirely unknown to the Egyptians of preceding times, and concerning which Manetho says nothing in what remains of his dynasties. The product resembles its source; not only is the whole full of absurdities, but they are absurdities peculiar to the work, and utterly irreconcilable with those which the priests of older times had related to Solon and Herodotus.

---

[*] Euterpe, cxli.

[†] Ibid. clix., and in the fourth Book of the Kings, chap. 19, or in the second of the Paral. chap. 32.

[‡] Syncell. p. 40.

It is Vulcan who commences the series of divine kings. He reigns 9000 years; the gods and demi-gods reign 1985 years. The names, and successions, and dates of Manetho are utterly unlike any thing that was published before or after him; and from the discrepancy of the extracts given by Josephus, Julius Africanus, and Eusebius, we may infer that his narratives were as obscure and confused in themselves, as they were discordant with those of other authors. Even the duration of the respective reigns of his human kings is not settled. According to Julius Africanus, it extended to 5101; according to Eusebius, to 4723; and according to Syncellus, to 3555 years. It might be thought that the differences in the names and cyphers arose from the inaccuracy of copyists; but Josephus quotes a passage at length, the details of which are manifestly in contradiction with the extracts of his successors.

A chronicle, named the *ancient*[*], and which some consider anterior, others posterior, to Manetho, gives still different calculations. The total duration of its kings is 36,525 years, of which the sun reigned 30,000, the other gods 3984, and the demi-gods 217; there remaining for those of the human race only 2339 years. There are thus also but 113 generations, in place of the 340 of Herodotus.

A learned man of an order different from that of Manetho, the astronomer Eratosthenes, discovered and published, in the reign of Ptolemy Euergetes, about 240 years before Christ, a particular list of thirty-eight kings of Thebes, commencing with Menes, and continuing for a space of 1024 years; of which we have an extract that Syncellus has copied from Apollodorus[†]. Scarcely any of the names found in this list correspond with those of the others.

Diodorus went to Egypt in the reign of Ptolemy Auletes, about sixty years before Christ, consequently two centuries after Manetho, and four after Herodotus. He also collected from the narratives of the priests a history of the country, and his account is again quite different from those of his predecessors[‡]. It is no longer Menes who built Memphis, but Uchoræus; and long before his time Busiris the second had built Thebes. The eighth ancestor of Uchoræus, Osymandyas, possessed himself of Bactria, and crushed rebellions in it. Long after him, Sesoosis made still more extensive conquests, having proceeded as far as the Ganges, and returned by Scythia and the Tanais. Unfortunately these names of kings are unknown to all the preceding historians, and none of the nations which they conquered have preserved the slightest traces of them. As to the gods and heroes, their reign, according to Diodorus, extended through a space of 18,000 years, while that of the human sovereigns was 15,000. Four hundred and seventy of the kings were Egyptians, and four Ethiopians, without reckoning the Persians and Macedonians. The fables, besides, with which the whole is intermingled, do not yield in childishness to those of Herodotus.

---

[*] Syncell. p. 51.

[†] Ibid. p. 91. *et seq.*

[‡] Diod. Sic. lib. i. sect. 2.

In the eighteenth year of the christian era, Germanicus, the nephew of Tiberius, led by the desire of becoming acquainted with the antiquities of this celebrated land, went over to Egypt, at the risk of incurring the displeasure of a prince so suspicious as his uncle, and proceeded up the Nile as far as Thebes. It was no more Sesostris or Osymandyas, of whom the priests spoke to him as a conqueror, but Rhamses, who, at the head of 700,000 men, had invaded Libya, Ethiopia, Media, Persia, Bactria, Scythia, Asia-Minor, and Syria *.

Lastly, in the celebrated article of Pliny upon the obelisks †, we find names of kings which are not to be seen elsewhere; Sothies, Mnevis, Zmarreus, Eraphius, Mestires, a Semenpserteus, contemporary of Pythagoras, &c. A Ramises, who might be thought the same as Rhamses, is there made to live at the time of the siege of Troy.

I am not sure whether it has been attempted to reconcile these discordant lists by the supposition that the kings have borne several names. For my own part, when I consider not only the discrepancy of these various accounts, but, above all, the mixture of authentic facts, attested by vast monuments, and of puerile extravagancies, it appears to me much more natural to conclude, that the Egyptian priests possessed no real history whatever; that, inferior still to those of

---

* Tacit. Annal. lib. ii. cap. 60.

N. B.—According to the interpretation given by Ammianus, lib. xvii. cap. 4., of the hieroglyphics on the obelisk of Thebes, which is at present in Rome in the place of St John of Latran, it appears that a Rhamestes was styled, after the eastern manner, lord of the habitable earth; and that the history told to Germanicus was only a commentary on this inscription.

† Pliny, lib. xxxvi. cap. 8, 9, 10, 11.

India, they had not even suitable and connected fables; that they preserved only lists more or less defective of their kings, and some remembrances of the more distinguished among them, of those especially who had taken care to have their names inscribed upon the temples and other great edifices which adorned their country; but that these remembrances were confused,—that they rested merely upon the traditional explanation which was given to the representations painted or sculptured upon the monuments; explanations founded solely upon hieroglyphical inscriptions, conceived, like that which has been handed down to us *, in very general terms, and which, passing from mouth to mouth, were altered, as to their details, at the pleasure of those who communicated them to strangers; and that it is consequently impossible to rest any proposition relative to the antiquity of the presently existing continents, upon the shreds of these traditions, so incomplete even in their own times, and become utterly unintelligible under the pen of those who have been the means of transmitting them to us.

Should this assertion require other proofs, they would be found in the list of the sacred works of

---

* That of Ramestes in Ammian. loc. cit.

Hermes, which were carried by the Egyptian priests in their solemn processions. Clement of Alexandria[*] names them all to the number of forty-two, and there is not even found among them, as is the case with the Brahmins, one epic poem, or one book, which has the pretension to be a narrative, or to fix in any way a single great action or a single event.

The interesting researches of M. Champollion the younger, and his astonishing discoveries regarding the language of the hieroglyphics[†], far from overturning these conjectures, on the contrary, confirm them. This ingenious antiquary has read, in a series of hieroglyphic paintings in the temple of Abydos[‡], the prenomens of a certain number of kings placed in regular succession one after another; and a part of these prenomens (the last ten) recurring on various other monuments, accompanied with proper names, he has concluded that they are those of kings who bore those proper names, and this has afforded him nearly the same kings, and in the same order, as those of which Manetho composes his eighteenth dynasty, that which expelled the shepherds. The concordance, however, is not complete: in the painting of Abydos, six of the names that appear in Manetho's list are wanting; there are some, again, which bear no resemblance; and, lastly, there unfortunately occurs a blank before the most remarkable of all, the Rhamses, who appears the same as the king represented on many of the finest monuments, with the attributes of a great conqueror. It would be, according to M. Champollion, in the list of Manetho, the Sethos, the chief of the nineteenth dynasty, who, in fact, is indicated as powerful in ships and in cavalry, and as having carried his arms into Cyprus, Media and Persia. M. Champollion thinks, with Marsham and many others, that it is this Rhamses, or this Sethos, who is the Sesostris, or the Sesoosis of the Greeks; and this opinion possesses some probability, in this respect, that the representations of the victories of Rhamses, probably carried over the wandering tribes in the vicinity of Egypt, or at the most into Syria, have given rise to those fabulous ideas of vast conquests attributed, by some other confusion, to a Sesostris. But, in Manetho, it is in the twelfth dynasty, and not in the eighteenth, that a prince bearing the name of Sesostris is inscribed, who is noted as having conquered Asia and Thrace [*]. Marsham also asserts, that this twelfth dynasty and the eighteenth make but one [†]. Manetho could not himself, therefore, have understood the lists which he copied. Lastly, if we admit in their full degree, both the historical truth of this bas-relief of Abydos, and its accordance, whether with the part of Manetho's lists that seems to correspond to it, or with the other hieroglyphic inscriptions, this consequence would result, that the pretended eighteenth dynasty, the first regarding which the ancient chronologists begin to manifest some agreement, is also the first which has left traces of its existence upon monuments. Manetho may have consulted this document and others of a like nature; but it is not the less obvious, that a mere list, a series of names or of portraits, as he has throughout, is far from being a history.

---

[*] Stromat. lib. vi. p. 633.

[†] See the "Precis du Systeme Hieroglyphique des Anciens Egyptiens," by M. Champollion the younger, p. 245; and his Letter to the Duke de Blacas, p. 15 et seq.

[‡] This important bas-relief is engraved in the second volume of M. Caillaud's Voyage à Meroë, Plate xxxii.

Ought not this, then, which is proved and demonstrated with respect to the Indians, and which I have rendered so probable with respect to the inhabitants of the valley of the Nile, be presumed also to be the case with those of the valleys of the Euphrates and Tigris? Established, like the Indians [‡] and Egyptians, upon a much frequented route of commerce, in vast plains, which they had been obliged to intersect with numerous canals; instructed, like them, by hereditary priests, the pretended depositaries of secret books, the privileged possessors of the sciences, astrologers, builders of pyramids, and other great monuments [*]; should they not also resemble them in other essential points? Should not their history be equally a mere collection of legendary tales? I venture almost to assert, that not only is this probable, but that it is actually demonstrated.

---

[*] Syncell, p. 59. [†] Canon, p. 355.

[‡] The whole ancient mythology of the Brahmins has

Up to this period neither Moses nor Homer speak of any great empire in Upper Asia. Herodotus [†] gives to the supremacy of the Assyrians a duration of only 520 years, and does not attribute to their origin a greater antiquity than about eight centuries before his own time. After having been at Babylon, where he consulted the priests, he had not even learnt the name of Ninus as king of the Assyrians, and does not mention him otherwise than as the father of Agro [‡], the first

---

relation to the plains or the course of the Ganges, where their first establishments were evidently formed.

[*] The descriptions of the ancient Chaldean monuments have a strong resemblance to what we see of those of the Indians and Egyptians; but these monuments are not equally well preserved, because they were only built of bricks dried in the sun.

[†] Clio, cap. xcv.

[‡] Clio, cap. vii.

Lydian king of the family of the Heraclides. Notwithstanding, he makes him the son of Belus: so much confusion had there been in the traditions. Though he speaks of Semiramis as one of the queens who left great monuments in Babylon, he only places her seven generations before Cyrus.

Hellanicus, who was cotemporary with Herodotus, far from allowing that Semiramis had built any thing at Babylon, attributes the foundation of that city to Chaldæus, the fourteenth successor of Ninus[*]. Berosus, a Babylonian and a priest, who wrote scarcely a hundred and twenty years after Herodotus, gives an astounding antiquity to Babylon; but it is to Nabuchodonosor, a prince comparatively very modern, that he attributes the principal monuments[†]. Regarding even Cyrus, a prince so remarkable, and whose history must have been so well known and so popular, Herodotus, who only lived a hundred years after him, owns that, in his time, there already existed three different opinions; and, in fact, sixty years later, Xenophon gives a biography of this prince quite at variance with that of Herodotus.

---

[*] Stephen of Byzantium, at the word *Chaldæi*.

[†] Josephus, (Contra App.) lib. i. cap. xix.

Ctesias, who was nearly cotemporary with Xenophon, pretends to have extracted from the royal archives of the Medes, a chronology which carries back the origin of the Assyrian monarchy upwards of 800 years, putting at the head of their kings, that same Ninus, the son of Belus, whom Herodotus had made one of the Heraclides; and, at the same time, he attributes to Ninus and Semiramis conquests towards the west, of an extent absolutely incompatible with the Jewish and Egyptian history of the times in question[*].

According to Megasthenes, it was Nabuchodonosor who made these incredible conquests. He pushed them by way of Libya, as far as Spain[†]. We find that, in the time of Alexander, Nabuchodonosor had completely usurped the reputation which Semiramis had possessed in the time of Artaxerxes. But we must suppose, without doubt, that Semiramis and Nabuchodonosor had conquered Ethiopia and Libya, much in the same way as the Egyptians made India and Bactria to be subdued by Sesostris or Osymandias.

---

[*] Diod. Sic. lib. ii.

[†] Josephus (contra App.) lib. i. cap. 6; and Strabo, lib. xv. p. 687.

It would lead to no result were we now to examine the different accounts respecting Sardanapalus, in which a celebrated writer imagined he had found proofs of the existence of three princes of that name, who were all victims of similar misfortunes*; much in the same way as another writer found in the Indian Vicramaditjia, at least three princes, who were equally the heroes of similar adventures.

It is apparently from the want of agreement in all these accounts, that Strabo thought himself justified in saying, that the authority of Herodotus and Ctesias was not equal to that of Homer or Hesiod †. Nor has Ctesias been more happy in transcribers than Manetho; and it is very difficult, at the present day, to harmonize the extracts made from his writings by Diodorus, Eusebius, and the Syncelle.

Since there existed such a state of uncertainty in the fifth century before the Christian era, how should it be imagined that Berosus had been able to clear it up in the third century before that era; or how should we repose more confidence in the 430,000 years which he puts before the deluge, or the 35,000 years which he places between the deluge and Semiramis, than in the registers of 150,000 years, which he boasts of having consulted *.

---

* See in the Memoirs of the Academy of Belles Lettres, vol. v. the memoir of Freret on the History of the Assyrians.

† Strabo, lib. xi. p. 507.

Structures raised in remote provinces, and bearing the name of Semiramis, have been spoken of; and columns erected by Sesostris† have been pretended to have been seen in Asia Minor, in Thrace. But, in the same way, in Persia, at the present day, the ancient monuments, perhaps even some of the above, bear the name of Roustan; and in Egypt or Arabia, they bear the names of Joseph or Solomon. This is an ancient custom among the eastern nations, and probably among all ignorant people. The peasants of our own country give the name of Cæsar's Camp to all the remains of Roman entrenchments.

In a word, the more I consider the subject, the more I am persuaded that there existed no ancient history at Babylon or Ecbatan, more than in Egypt and India. And, in place of reducing

---

* Syncellus, p. 38 and 39.

† N. B.—It is very remarkable that Herodotus does not mention having seen monuments of Sesostris, except in Palestine, and does not speak of those of Ionia, but upon the authority of others, adding, at the same time, that Sesostris is not named in the inscriptions, and that those who had seen these monuments attributed them to Memnon. See Euterpe, chap. cvi.

mythology to history, with Evhemere and Bannier, I am of opinion that a great part of history should be referred to mythology.

It is only at the epoch of what is commonly called the Second Kingdom of Assyria, that the history of the Assyrians and Chaldeans begins to become more intelligible; and this epoch is also that at which the history of the Egyptians undergoes a similar change, when the kings of Nineveh, of Babylon, and of Egypt, commence their conflicts on the theatre of Syria and Palestine.

It appears, nevertheless, that the authors of these countries, or those who had consulted the traditions regarding them, Berosus, and Hieronymus, and Nicholas de Damas, agreed in speaking of a deluge. Berosus has even described it with circumstances so similar to those detailed in the book of Genesis, that it is almost impossible what he says of it should not have been derived from the same sources, even although he removes its epoch a great number of ages back,—insomuch, at least, as we may judge of it, by the confused extracts which Josephus, Eusebius, and Syncellus, have preserved of his writings. But we must remark, and with this observation we shall conclude what we have to say with regard to the Babylonians, that these numerous ages, and this long series of kings, placed between the deluge and Semiramis, are a new thing, entirely peculiar to Berosus, and of which Ctesias, and those who have followed him, had no idea, and which has not even been adopted by any of the profane authors posterior to Berosus. Justin and Velleius consider Ninus as the first of the conquerors, and those who, contrary to all probability, place him highest, only refer him to a period of forty centuries before the present time[*].

The Armenian authors of the middle age nearly agree with one of the texts of Genesis, when they refer the deluge to a period of 4916 years from their own time; and it might be thought that having collected the old traditions, and perhaps extracted the old chronicles of their country, they form an additional authority in favour of the newness of the nations. But when we reflect that their historical literature commences only in the fifth century, and that they were acquainted with Eusebius, we perceive that they must have accommodated themselves to his authority, and to that of the Bible. Moses of Chorene expressly professes to have followed the Greeks, and we see that his ancient history is moulded after Ctesias[†].

However, it is certain, that the tradition of the deluge existed in Armenia long before the conversion of its inhabitants to christianity; and the city, which, according to Josephus, was called *the Place of the Descent*, still exists at the foot of Mount Ararat, and bears the name of *Nachidchevan*, which, in fact, has the same signification.*

---

[*] Justin, lib. i. cap. i. Vetleius Paterculus, lib. i. cap. 7.

[†] See Moses of Chorene, Histor. Armeniac. lib. 1. cap. i.

Along with the Armenians, we include the Arabians, Persians, Turks, Mongolians, and Abyssinians, of the present day. Their ancient books, if they ever had any, no longer exist. They have no ancient history, but that which they have recently made up, and which they have modelled after the Bible; hence, what they say of the deluge is borrowed from Genesis, and adds nothing to the authority of that book.

It were curious to inquire what had been the opinion of the ancient Persians upon this subject, before it was modified by the Christian and Mahomedan creeds. We find it deposited in their Boundehesh, or Cosmogony, a work of the time of Sassanides, (but evidently extracted or translated from more ancient works), and which was discovered by Anquetil du Perron, among the Parsis of India. According to it, the total duration of the world could only be 12,000 years; hence it cannot still be very old. The appearance of *Cayoumortz* (the bull-man, the first of the human race), is preceded by the creation of a great water.[*]

---

* See the Preface of the Brothers Whiston, regarding Moses of Chorene, p. 4.

For the rest, it would be as useless to expect a regular history of ancient times from the Parsis, as from the other eastern nations. The Magi have left none, any more than the Brahmins or Chaldeans. Of this there is nothing more required for proof than the uncertainty which exists regarding the epoch of Zoroaster. It is even asserted, that the little history they may have possessed, that which relates to the Achemenides, the successors of Cyrus to Alexander, had been expressly altered, and this in consequence of an official order to that purpose from a monarch named Sassanides[†].

In order to discover authentic dates of the commencement of empires, and traces of a general deluge, we must therefore go beyond the great deserts of Tartary. Toward the east and north we find another race of men, who differ from us as much in their institutions and manners as in their form and temperament. Their language consists of monosyllables, and they make use of arbitrary hieroglyphics in writing. They have only a political system of morals, without religion; for the superstitions of Fo were imported among them from India. Their yellow skin, their prominent cheeks, their narrow and oblique eyes, and their scanty beard, render them so different from us, that one is tempted to believe that their ancestors and ours had escaped the great catastrophe on two different sides. But however this may be, the epoch which they assign to their deluge is nearly the same as ours.

---

[*] Zendavesta of Anquetil, vol. ii. p. 354.

[†] Mazoudi, ap. Sacy, MS. of the Royal Library, vol. viii. p. 161.

The Chou-king is the most ancient of the Chinese books *; it is said to have been compiled by Confucius, about 2255 years ago, from fragments of more ancient works. Two hundred years afterwards, a general persecution of the men of letters, and destruction of the books, is said to have taken place under the emperor Chi-Hoang-ti, whose object in this was to destroy the traces of the feudal government established under the dynasty which preceded his. Forty years after, under the dynasty which had overturned that to which Chi-Hoang-ti belonged, a portion of the Chou-king was restored from memory by an old literatus, and another was discovered in a tomb; but nearly the half of it was for ever lost. Now, this book, the most authentic which the Chinese

---

* See the preface to the edition of Chou-king, by M. de Guignes.

possess, commences the history of their country with the reign of an emperor named *Yao*, whom it represents to us as occupied in removing the waters, *which, having risen to the skies, still bathed the foot of the higher mountains, covered the less elevated hills*, and rendered the plains impassable *. According to some, the reign of Yao was 4163 years before the present time; according to others, 3943. The discrepancy in the opinions regarding this epoch even amounts to 284 years.

A few pages farther on we find one *Yu*, a minister and engineer, re-establishing the courses of the waters, raising embankments, digging canals, and regulating the taxes of all the provinces in China, that is to say, in an empire extending 600 leagues in all directions. But the impossibility of such operations, after such events, shews clearly that the whole is nothing else than a moral and political romance †.

More modern Chinese historians have added a series of emperors before Yao, but with a multitude of fabulous circumstances, without venturing to assign them fixed epochs. These writers are at perpetual variance with each other, even regarding the number and names of their emperors, and are not universally approved by their countrymen. Fouhi, with the body of a serpent, the head of an ox, and the teeth of a tortoise, together with his successors, who are not less monstrous, are altogether absurd, and have no more existed than Enceladon and Briareus.

---

* Chou-king, French translation, p. 9.

† See the Yu-kong, or first chapter of the second part of the Chou-king, pp. 43--60.

Is it possible that mere chance could have produced so striking a result, as to make the traditional origin of the Assyrian, Indian, and Chinese monarchies agree in being referred to an epoch of nearly 4000 years from the present period? Would the ideas of nations which have had so little communication with each other, and whose language, religion, and laws are altogether different, have corresponded upon this point, had they not been founded upon truth?

We could not expect precise dates from the natives of America, who had no real writings, and whose oldest traditions extended only to a few centuries before the arrival of the Spaniards. And yet, even among them, traces of a deluge are imagined to be found in their rude hieroglyphics. They have their Noah, or Deucalion, as well as the Indians, Babylonians, and Greeks *.

---

* See the excellent and magnificent work of M. de Humboldt upon the Mexican monuments.

The Negroes, the most degraded race among men, whose forms approach the nearest to the brutes, and whose intellect has not yet arrived at the institution of regular governments, or at any thing having the least appearance of systematic knowledge, have preserved no sort of annals or traditions. They cannot, therefore, afford us any information on the subject of our present researches, though all their characters clearly shew us that they have escaped from the great catastrophe, at another point than the Caucasian and Altaic races, from which they had perhaps been separated for a long time previous to the occurrence of that catastrophe.

But if the ancients, it is argued, have left no history, their long existence as nations is not the less attested by the advances which they have made in astronomy, by observations whose date is easily determined, and even by monuments which still remain, and which themselves bear their dates. Thus, the length of the year, such as the Egyptians are supposed to have determined it, according to the heliacal rising of Sirius, proves correct for a period comprised between the year 3000 and the year 1000 before Christ, a period to which the traditions of their conquests and of the great prosperity of their empire also refer. This accuracy proves to what perfection they had carried their observations, and shews that they had for many ages applied themselves to such investigations.

In order to determine the force of this argument, it is necessary that we should here enter upon some explanations.

The solstice is the moment of the year at which the rise of the Nile commences, and that which the Egyptians must have observed with most attention. Having, at the beginning, made, from imperfect observations, a civil or sacred year of three hundred and sixty-five days complete, they would preserve it from superstitious motives, even after they had perceived that it did not agree with the natural or tropical year, and did not bring back the seasons to the same days [*]. However, it was this tropical year which it behoved them to mark for the purpose of directing them in their agricultural operations.

They would, therefore, have to search in the heavens for an apparent sign of its return, and they imagined they had found this sign when the sun returned to the same position, relatively to some remarkable star. Thus they applied themselves, like almost all nations who are beginning this inquiry, to observe the heliacal risings and settings of the stars. We know that they chose particularly the heliacal rising of Sirius, at first, doubtless, on account of the beauty of the star; and, especially, because, in those ancient times, this rising of Sirius being nearly coincident with the solstice, and indicative of the inundation, was to them the most important phenomenon of this kind. Hence it was that Sirius, under the name of Sothis, occupied so conspicuous a place in their mythology, and in their religious ceremonies. Supposing, therefore, that the return of the heliacal rising of Sirius and the tropical year were of the same duration, and believing, at length, that this duration was 365 days and a quarter, they would imagine a period after which the tropical year and the old year, the sacred year of 365 days only, would return to the same day; a period which, according to these incorrect data, was necessarily 1461 sacred years, and 1460 of those improved years to which they gave the name of years of Sirius.

---

[*] Geminus, who was cotemporary with Cicero, explains their motives at length. See M. Halma's edition at the end of the Ptolomée, p. 43.

They took for the point of departure of this period, which they named the Sothiac or great year, a civil year, the first day of which was, or had been, also that of a heliacal rising of Sirius; and it is known, from the positive testimony of Censorinus, that one of these great years had ended in the 138th year of the christian era[*]. It had consequently commenced in the 1322d before Christ, and that which preceded it in the 2782d. In fact, the calculations of M. Ideler shew, that Sirius was heliacally risen on the 20th July of the Julian year 139, a day which corresponded that year to the first of Thot, or the first day of the Egyptian sacred year[†].

But not only is the position of the sun, with relation to the stars of the ecliptic, or the sidereal year different from the tropical year, on account of the precession of the equinoxes. The heliacal year of a star, or the period of its heliacal rising, especially when it is distant from the ecliptic, differs still from the sidereal year, and differs in various degrees according to the latitudes of the places where it is observed. What is very singular, however, and the observation has already been made by Bainbridge[‡] and Father Petau[§], it happens, by a remarkable concurrence in the positions, that, in the latitude of Upper Egypt, at a certain epoch, and during a certain number of ages, the year of Sirius was really within very little of 365 days and a quarter; so that the heliacal rising of this star returned in fact to the same day of the Julian year, the 20th July, in the year 1322 before, and the year 138 after Christ *.

---

[*] The whole of this system is developed by Censorinus, De Die Natali, cap. xviii. and xxi.

[†] Ideler. Historical Researches regarding the Astronomical Observations of the Ancients. M. Halma's translation, at the end of his Canon de Ptolomée, p. 32. *et seq.*

[‡] Bainbridge, Canicul.

[§] Petau, Var. Dios. lib. v. cap. vi. p. 108.—Also, La Nanze, Acad. de Bell. Lett. t. xiv. p. 346.

From this actual coincidence, at this remote period, M. Fourier, who has confirmed all these accounts by new calculations, concludes, that, since the length of the year of Sirius was so perfectly known to the Egyptians, they must have determined it by observations made during a long series of years, and conducted with great accuracy; observations which must be referred to at least 2500 years before the present time, and which could not have been made long before or long after this interval of time †.

---

* Petau. loc. cit. M. Ideler asserts that this concurrence of the heliacal rising of Sirius also took place in 2782 before Christ. (Historical Researches in M. Halma's Ptolomée, vol. iv. p. 37.) But with regard to the Julian year 1598 after Christ, which is also the last of a great year, Petau and Ideler differ much from each other. The latter refers the heliacal rising of Sirius to the 22d July; the former to the 19th or 20th of August.

† See, in the great work on Egypt, Antiq. Memoirs, vol. 1. p. 803. the ingenious Memoir of M. Fourier, enti-

This result would assuredly be very striking, had it been directly, and by observations, made upon Sirius itself, that they had fixed the length of the year of Sirius. But experienced astronomers affirm it to be impossible that the heliacal rising of a star could afford a sufficient foundation for exact observations on such a subject, especially in a climate where *the circumference of the horizon is constantly so much loaded with vapours, that, in clear nights, stars of the second or third magnitude can never be seen within some degrees of the verge of the horizon, and that the sun itself is completely obscured at its rising and setting.*[*] They maintain, that, if the length of the year had not been otherwise ascertained, there would have been a mistake of one or two days.[†] They have no doubt, therefore, that this duration of 365 days and a quarter, is that of the tropical year inaccurately determined by the observation of the shadow, or by that of

---

tled Recherches sur les Sciences et le Gouvernement de l'Egypte.

[*] These are the words of the late M. Nouet, Astronomer to the Expedition to Egypt. See Volney, New Inquiries regarding Ancient History, vol. iii.

[†] Delambre, Abregé d'Astronomie, p. 217; and in his note upon the Parantaellons, in his History of the Astronomy of the Middle Age, p. lij.

the point where the sun rose each day, and through ignorance identified with the heliacal year of Sirius; so that it would be mere chance which had fixed with so much accuracy the duration of this latter for the period of which we speak.[*]

Perhaps it will also be judged, that men capable of making observations so exact, and which they had continued during so long a period, would not have attributed so much importance to Sirius, as to pay him religious homage; for they would have seen that the relations of the rising of this star with the tropical year, and with the inundation of the Nile, were merely temporary, and took place only in a determinate latitude. In fact, according to M. Ideler's calculations, in the year 2782 before Christ, Sirius appeared in Upper Egypt, on the second day after the solstice; in 1322, on the third; and in the year 139 after Christ, on the twenty-sixth.[†] At the present day, its heliacal rising is more than a month after the solstice. The Egyptians would therefore set themselves by preference to finding the period, which would bring about the coincidence of the commencement of the sacred year, with that of the true tropical year, and then they would discover that their great period must have been 1508 sacred years, and not 1461.* Now, we assuredly do not find any traces of this period of 1508 years in antiquity.

---

[*] Delambre, Report upon M. de Paravey's Memoir regarding the Sphere, in the 8th vol. of the Nouvelles Annales des Voyages.

[†] Ideler, loc. cit. p. 38.

In general, we may defend ourselves with the idea, that, if the Egyptians had possessed so long a series of observations, and of accurate observations too, their disciple Eudoxus, who studied among them for thirteen years, would, on his return, have brought into Greece a system of astronomy more perfect, and maps of the heavens less erroneous, and more coherent in their different parts.† How should it happen that the precession of the equinoxes was not known to the Greeks, but through the works of Hipparchus, if it had been marked in the registers of the Egyptians, and inscribed in characters so manifest upon the ceilings of their temples? And how comes it that Ptolemy, who wrote in Egypt, should not have deigned to avail himself of any of the observations of the Egyptians? *

---

* See Laplace, Systeme du Monde, 3d edition, p. 17; and the Annuaire of 1818.

† See on the Inaccuracy of the Determinations of the Sphere of Eudoxus, M. Delambre, in the first volume of his History of the Astronomy of the Ancients, p. 120. et seq.

Farther, Herodotus, who lived so long with them, says nothing of those six hours which they added to the sacred year, nor of that great Sothian period which resulted. On the contrary, he says expressly that the Egyptians, making their year of 365 days, the seasons returned to the same point, so that in his time the necessity of this quarter of a day does not appear to have been suspected. † Thalles, who had visited the priests of Egypt, less than a century before Herodotus, did not, in like manner, make known to his countrymen, any other than a year of 365 days only. ‡ And, if we reflect that all the colonies which migrated from Egypt, fourteen or fifteen centuries before Christ, the Jews and the Athenians, carried with them the lunar year, it will perhaps be inferred that the year of 365 days itself had not existed in Egypt in these remote ages.

I am aware that Macrobius § gives the Egyptians a solar year of 365¼ days; but this author,

---

* See the Preliminary Discourse of the History of the Astronomy of the Middle Age, by M. Delambre, p. viii. et seq.

† Euterpe, chap. iv. ‡ Diog. Laert, lib. i. in Thalet.

§ Saturnal. lib. i. cap. xv.

who is comparatively modern, and who lived at a long period after the establishment of the fixed year of Alexandria, must have confounded the epochs. Diodorus [*] and Strabo [†] only attribute such a year to the Thebans; they do not say that it was in general use, and they themselves did not live till long after Herodotus.

Thus the Sothian or great year must have been a comparatively recent invention, since it results from the comparison of the civil year with this pretended heliacal year of Sirius; and it is for this reason that it is only spoken of in the works of the second and third century after Christ [‡], and that Syncellus alone, in the ninth, seems to cite Manetho as having made mention of it.

Notwithstanding all that is said to the contrary, the same opinion must be formed of the astronomical knowledge of the Chaldeans. It is natural enough to think, that a people who inhabited vast plains, under a sky perpetually serene, must have been led to observe the course of the stars, even at a period when they still led a wandering life, and when the stars alone could direct their courses during the night; but since what period were they astronomers, and to what perfection did they carry the science? Here rests the question. It is generally allowed that Callisthenes sent to Aristotle observations made by them, and which referred to a period of 2200 years before Christ; but this fact is related only by Simplicius [*], as stated upon the authority of Porphyry, and 600 years after Aristotle. Aristotle himself says nothing on the subject, nor has any creditable astronomer spoken of it. Ptolemy mentions and makes use of ten observations of eclipses really made by the Chaldeans; but they do not refer to an earlier period than that of Nabonassar (721 years before Christ); they are inaccurate also; the time is expressed only in hours and half-hours, and the shadow only in halves or fourths of the diameter. Notwithstanding, as they had fixed dates, the Chaldeans must have had some knowledge of the true length of the year, and some means of measuring time. They appear to have known the period of eighteen years, which brings back the eclipses of the moon in the same order; a piece of knowledge which the mere inspection of their registers would promptly afford them; but it is certain that they could neither explain nor predict eclipses of the sun.

---

[*] Bibl. lib. i. p. 46.

[†] Geogr. p. 182.

[‡] See regarding the probable newness of this period the excellent dissertation of M. Biot, in his Researches respecting several points of the Egyptian Astronomy, p. 148 *et seq*.

---

[*] See M. Delambre, Hist. de l'Astronomie, vol. i. p. 212. See also his analysis of Geminus, *ibid.* p. 211. Compare this with M. Ideler's Memoirs on the Astronomy of the Chaldeans, in the fourth volume of M. Halma's Ptolemy, p. 166.

It is from not having sufficiently understood a passage of Josephus, that Cassini, and after him Bailly, have imagined that they discovered in it a luni-solar period of 600 years, which had been known from the time of the first patriarchs *.

Thus every thing leads us to believe that the great reputation of the Chaldeans was given them at a more recent period, by their unworthy successors, who, under the same name, sold their horoscopes and predictions throughout the whole Roman empire, and who, in order to procure themselves more credit, attributed to their rude ancestors the honour of the discoveries of the Greeks.

With regard to the Indians, every body knows that Bailly, believing that the epoch which is used as a period of departure in some of their astronomical tables had been actually observed, has attempted to draw from thence a proof of the great antiquity of the science among this people,

---

* See Bailly, History of Ancient Astronomy; and M. Delambre, in his work on the same subject, vol. i. p. 3.

or at least among the nation which had bequeathed them its knowledge. But the whole of this system, invented with so much labour, falls to the ground of itself, now that it is proved that this epoch has been adopted but of late, from calculations made backwards, and even false in their results.*

Mr Bentley has discovered that the tables of Tirvalour, on which the assertion of Bailley especially rested, must have been calculated about 1281 of the Christian era, or 540 years ago, and that the Surya-Siddhanta, which the Brahmins regard as their oldest scientific treatise on astronomy, and which they pretend to have been revealed upwards of 20,000,000 of years ago, could not have been composed at an earlier period than about 760 years from the present day †.

Solstices and equinoxes indicated in the Pouranas, and calculated according to the positions which seem to be attributed to them by the signs of the Indian zodiac, such as they are supposed to be, have acquired the character of an enormous antiquity. A more attentive examination of these signs or nacchatras has lately convinced M. de Paravey that reference is only made to solstices of 1200 years before the Christian era. This author at the same time admits, that the place of the solstices is so inaccurately fixed, that this determination of their date must be received with a latitude of 200 or 300 years. They are in the same predicament as those of Eudoxus and of Tcheoukong[*].

---

* See Laplace, Exposé du Systeme du Monde, p. 330; and the Memoir of Mr Davis, on the Astronomical Calculations of the Indians.—Calcutta Memoirs, vol. ii. p. 225, 8vo. edition.

† See Mr Bentley's Memoirs on the Antiquity of the Surya-Siddhanta, Calcutta Memoirs, vol. vi. p. 540; and on the Astronomical Systems of the Indians, ibid., vol. viii. p. 195. of the 8vo edition.

It is ascertained that the Indians do not make observations, and that they are not in possession of any of the instruments necessary for that purpose. M. Delambre indeed admits, with Bailly and Legentil, that they have processes of calculation, which, without proving the antiquity of their astronomy, shew at least its originality[†]; and yet this conclusion can by no means be extended to their sphere; for, independently of their twenty-seven nacchatras or lunar houses, which strongly resemble those of the Arabians, they have the same twelve constellations in the zodiac as the Egyptians, Chaldeans, and Greeks *; and, if we refer to Mr Wilfort's assertions, their extra-zodiacal constellations are also the same as those of the Greeks, and bear names which are merely slight alterations of their Greek names †.

---

[*] Manuscript Memoirs of M. de Paravey, on the sphere of Upper Asia.

[†] See the profound essay on the Astronomy of the Indians in M. Delambre's Histoire de l'Astronomie ancienne, vol. i. p. 400–556.

It is to Yao that the introduction of astrono-

---

* See the Memoir of Sir William Jones, on the Antiquity of the Indian Zodiac, Calcutta Memoirs, vol. ii. p. 289 of the 8vo edition.

† The following are Mr Wilfort's own words, in his memoir on the Testimonies of Ancient Hindoo Books, respecting Egypt and the Nile, Calcutta Memoirs, vol. iii. p. 433 of the 8vo edition:

—"Having desired my pundit, who is a learned astronomer, to point out in the heavens the constellation of Antarmada, he directed me immediately to Andromeda, which I had taken care not to shew him as a constellation that I knew. He afterwards brought me a very rare and curious book, in Sanscrit, in which there was a particular chapter on the Upanacshatras, or extra-zodiacal constellations, with figures of Capeya, of Casyape, seated, and holding a lotus-flower in her hand; of Antarmada, chained, with the fish near her; and of Parasica, holding the head of a monster, which he had killed, dropping blood, and having snakes for hair."

Who does not recognise in this, Perseus, Cepheus, and Cassiope? But we must not forget that this pundit of Mr Wilfort's has become much suspected.

my into China is attributed. He is represented, in the Chou-king, as sending astronomers toward the four cardinal points of his empire, to examine what stars presided over the four seasons, and to regulate the operations to be carried on at each period of the year[*], as if their dispersion was necessary for such an undertaking. About 200 years later, the Chou-king speaks of an eclipse of the sun, but accompanied with ridiculous circumstances, as in all the fables of this kind; for the whole Chinese army, headed by a general, is made to march against two astronomers, because they had not properly predicted it[†]; and it is well known that, more than 2000 years after, the Chinese astronomers possessed no means of accurately predicting the eclipses of the sun. In 1629 of our era, at the time of their dispute with the Jesuits, they did not even know how to calculate the shadows.

The real eclipses, recorded by Confucius in his Chronicle of the kingdom of Lou, commence only 1400 years after this, in the 776th before Christ, and scarcely half a century earlier than those of the Chaldeans related by Ptolemy. So true is it, that the nations which escaped at the same time from the general catastrophe, also arrived about the same period, when their circumstances have been similar, at the same degree of civilization. Now, it might be thought, from the identity of the names of the Chinese astronomers in different reigns (they appear, according to the Chou-king, to have all been named *Hi* and *Ho*), that, at this remote epoch, their profession was hereditary in China, as it was in India, Egypt, and Babylon.

---

[*] Chou-king, p. 6 and 7.

[†] Idem, p. 66. *et seq.*

The only Chinese observation of any antiquity, which has nothing in itself to prove its want of authenticity, is that of the shadow made by *Tcheou-kong* about 1100 years before Christ; and even it is far from being correct [*].

Hence our readers may conclude, that the inferences drawn from the alleged perfection of astronomical science among ancient nations, is not more conclusive in favour of the excessive antiquity of those nations, than the testimonies which they have adduced in reference to themselves.

But had this astronomy been more perfect, what would it prove? Has the progress been calculated which this science ought to make among nations who were not in any degree in possession of others; to whom the serenity of the sky, the necessities of the pastoral or agricultural life, and their superstitious ideas, would render the stars an object of general attention; where colleges, or societies of the most respectable men among them, were charged with keeping a register of interesting phenomena, and transmitting their memory; and where, from the hereditary nature of the profession, the children were brought up from the cradle in the knowledge of facts ascertained by their parents? Supposing that, among the numerous individuals of whom the cultivation of astronomy was the sole occupation, there should happen to be one or two possessed of extraordinary talents for geometry, all the knowledge acquired by these nations might be attained in a few centuries.

---

[*] See, in the Connaissance des Temps of 1809, p. 382, and in M. Delambre's Histoire de l'Astronomie ancienne, vol. i. p. 391, the extract of a memoir by P. Gaubil, on the Observations of the Chinese.

Since the time of the Chaldeans, real astronomy has only had two eras, that of the Alexandrian school, which lasted 400 years, and that of our own times, which has not existed so long. The learned period of the Arabians scarcely added any thing to it; and the other ages have been mere blanks with regard to it. Three hundred years did not intervene between Copernicus and the author of the *Mecanique Céleste;* and can it be believed that the Indians required thousands of years to arrive at their crude theories?

The Astronomical Monuments left by the Ancients do not bear the excessively remote dates which have been attributed to them.

Recourse has therefore been had to arguments of another kind. It has been pretended that, independently of the knowledge which these nations may have acquired, they have left monuments which bear a date fixed by the state of the heavens which they represent, and one that refers to a very remote antiquity. The zodiacs sculptured in two temples of Upper Egypt, are adduced as furnishing proofs perfectly demonstrative of this assertion. They present the same figures of the zodiacal constellations as are employed at the present day, but distributed in a manner peculiar to themselves. The state of the heavens at the period when these monuments were delineated, is imagined to have been represented by this distribution, and it has been thought that it would be possible from it to infer the precise period at which the edifices containing them were erected[*].

---

[*] Thus at Dendera, the ancient Tentyris, a city below Thebes, in the portico of the great temple, the entrance of which faces the north, there are seen on the ceiling the signs of the zodiac marching in two bands, one of which

But to arrive at the high antiquity which is supposed to be deducible from this, it must, in

---

extends along the eastern side, and the other along the opposite one. Each of the bands is embraced by the figure of a woman of the same length, the feet of which are toward the entrance, the head and arms toward the bottom of the portico; the feet are consequently to the north, and the heads to the south. (Great Work on Egypt, Antiq. vol. ix. pl. 20.)

The Lion is at the head of the band which is on the western side; his direction is toward the north, or toward the feet of the figure of the woman, and his feet are toward the eastern wall. The Virgin, the Balance, the Scorpion, the Saggittary and the Capricorn, follow marching in the same line. The latter is placed toward the bottom of the portico, and near the hands and head of the large figure of the woman. The signs of the eastern band commence at the extremity where those of the other band terminate, and are consequently directed toward the bottom of the portico, or toward the arms of the large figure. They have the feet toward the lateral wall of their own side, and the heads in the contrary direction to those of the opposite band. The Aquarius marches first, and is followed by the Fishes, the Ram, the Bull, and the Twins. The last of the series, which is the Crab, or rather the Scarabæus, (for this insect is substituted for the crab in the zodiacs of Egypt), is thrown to a side upon the legs of the large figure. In the place which it should have occupied is a globe resting upon the summit of a pyramid, composed of small triangles, which represent a sort of rays, and before the base of which is a large head of a woman with two small horns. A second scarabæus is placed awry and cross-wise upon the

the *first* place, be supposed, that their division has a determinate relation to a certain state of

---

first band, in the angle which the feet of the large figure form with the body, and before the space in which the Lion marches, which is a little behind. At the other end of this same band, the Capricorn is very near the bottom, or at the arms of the large figure; and, upon the left band, the Aquarius is separated to some distance from it. The Capricorn, however, is not repeated like the Crab. The division of this zodiac, from the entrance, is therefore made between the Lion and the Cancer; or if it be thought that the repetition of the Scarabæus marks a division of the sign, it takes place in the Crab itself; but that of the lower end is made between the Capricorn and Aquarius.

In one of the inner halls of the same temple, there was a circular planisphere inscribed in a square, the same that has been brought to Paris by M. Lelorrain, and which is to be seen at the Royal Library. In it, also, the signs of the zodiac are observed among many other figures which appear to represent constellations. (Great Work on Egypt, Antiq. vol. iv. pl. 21.) The Lion corresponds to one of the diagonals of the square; the Virgin, which follows, corresponds to a perpendicular line which is directed toward the east; the other signs march in the usual order, till we come to the Crab, which, in place of completing the chain, by corresponding to the level of the Lion, is placed above it, nearer the centre of the circle, in such a manner that the signs are upon a somewhat spiral line. This Crab, or rather Scarabæus, marches in a contrary direction to the other signs. The Twins correspond to the north, the Sagittary to the south, and the Fishes to the east, but not very exactly. At the eastern side of this planisphere is a large figure of a the heavens, dependent upon the precession of the equinoxes, which causes the colures to make

---

woman, with the head directed toward the south, and the feet toward the north, like that of the portico. Some doubt might therefore also be raised regarding the point at which the series of the signs ought to commence. According as one of the perpendiculars or one of the diagonals is taken, or the place where one part of the series passes over the other part, the division will be judged to be at the *Lion*, or between the Lion and the Crab; or lastly at the Twins.

At Esne, the ancient Latopolis, a city placed above Thebes, there are zodiacs on the ceilings of two different temples. That of the great temple, the entrance of which faces the east, is upon two bands, which are contiguous and parallel to one another, along the south side of the ceiling. The female figures which embrace them are not placed in the direction of their length, but in that of their breadth, so that one lies across near the entrance, or to the east, the head and arms toward the north, and the feet toward the lateral wall, or toward the south, and the other is in the bottom of the portico, equally across, and looking toward the first. The band nearest the axis of the portico, or the north, presents first, on the side of the entrance, or east, and toward the head of the female figure, the *Lion*, placed a little behind, and marching toward the bottom, the feet directed toward the lateral wall. Behind the Lion, at the commencement of the band, are two smaller Lions. Before it is the Scarabæus, and then the Twins marching in the same direction; then the Bull and the Ram, and the Fishes close to each other, placed across upon the middle of the band, the Bull having its head toward the lateral wall, the ram toward the axis. The Aquarius is more distant, the tour of the zodiac in 26,000 years; that it indicated, for example, the position of the sol-

---

and resumes the same direction toward the bottom as the first signs. On the band nearest the lateral wall and the north, we see first, but at a considerable distance from the wall of the bottom, or the west, the Capricorn, which marches in a contrary direction to the Aquarius, and is directed toward the east, or the entrance of the portico, having the feet turned toward the lateral wall. Close upon it is the Sagittarius, which thus corresponds with the Fishes and Ram. It also marches toward the entrance; but its feet are turned toward the axis, and in a contrary direction to those of the Capricorn. At a certain distance before, and placed near one another, are the Scorpion and a woman holding the Balance. Lastly, a little before, but still at a considerable distance from the anterior or eastern extremity, is the Virgin which is preceded by a sphinx. The Virgin and the woman holding the Balance, have also their feet toward the wall, so that the Sagittary is the only one which is placed with its head contrary to the other signs.

To the north of Esne is a small isolated temple, equally facing the east, and having a zodiac also in its portico (Great Work on Egypt, Antiquities, vol. i. Plate 87.) This zodiac is upon two lateral and separated bands. That which extends along the south side commences with the Lion, which marches toward the bottom, or toward the west, the feet turned toward the wall, or the south. It is preceded by the Scarabæus, and the latter by the Gemini, marching in the same direction. The Bull, on the contrary, faces them, having a direction toward the east. But the Ram and the Fishes resume the direction toward the bottom, or toward the west. On the band of the north stitial point; and, *secondly*, that the state of the heavens represented was precisely that which took place at the period when the monument was

---

side, the Aquarius is near the bottom, or the west, marching towards the entrance or east, the feet turned toward the wall, preceded by the Capricorn and Sagittary, both marching in the same direction. The other signs are lost; but it is clear that the Virgin must have marched at the head of this band, on the side next the entrance. Among the accessory figures of this small zodiac, must be remarked two winged Rams placed across, the one between the Bull and the Twins, the other between the Scorpion and Sagittary, and each nearly in the middle of its band; the second, however, a little more advanced toward the entrance.

It was at first thought, that, in the great zodiac of Esne, the division of the entrance took place between the Virgin and the Lion, and that of the bottom between the Fishes and the Aquarius. But Mr Hamilton, and MM. de Jollois and Villiers, have supposed, that, in the Sphinx, which precedes the Virgin, they found a repetition of the Lion, analogous to that of the Cancer in the great zodiac of Dendera; so that, according to them, the division would be at the Lion. In fact, without this explanation, there would only be five signs on one side, while there would be seven on the other.

With regard to the small zodiac of the north of Esne, it is not known whether some emblem analogous to this Sphinx may have occurred in it, because this part is destroyed.—See British Review, February 1817, p. 136; and Critical Letter on Zodiacomania, p. 33.

erected,—two suppositions which themselves, as is evident, suppose a great number of others.

In point of fact, are the figures of these zodiacs the constellations,—the true groups of stars which at present bear the same names, or merely what astronomers call signs, that is to say, divisions of the zodiac proceeding from one of the colures, whatever place this colure occupies? Is the point at which these zodiacs have been divided into two bands, necessarily that of a solstice? Is the division of the side next the entrance, necessarily that of the summer solstice? Does this division indicate, even in general, a phenomenon dependent upon the precession of the equinoxes? Does it not refer to some period the rotation of which would be less; for example, to the moment of the tropical year when such or such sacred years of the Egyptians commenced, which, being shorter than the true tropical year by nearly six hours, would make the tour of the zodiac in 1508 years? Lastly, whatever signification it may have had, has it been intended by it to mark the time when the zodiac was sculptured, or that when the temple was built? Has not the object been to record a previous state of the heavens at some period which was interesting in a religious point of view, whether it had been actually observed, or inferred from a retrograde calculation?

From the mere announcement of such questions, it will be perceived how complicated they necessarily are, how much subject to controversy any solution that might be adopted on this subject would be, and how little qualified to serve as a solid proof, for the solution of another problem, such as the antiquity of the Egyptian nation. And it may be said, with regard to those who have attempted to infer a date from these data, that there have arisen as many opinions as there have been authors.

The learned astronomer Mr Burkhard, from a first examination, judged that, at Dendera, the solstice is marked by the Lion; which would make it two signs less remote than at the present day, and the temple at least 4000 years old *. He gave, at the same time an antiquity of 7000 years to that of Esne, although it is not known how he had purposed to reconcile these numbers with what we know of the precession of the equinoxes. The late M. Lalande, seeing that the Cancer was repeated on the two bands, imagined that the solstice passed to the middle of that constellation; but as this was the case also in the sphere of Eudoxus, he concluded that some Grecian artist might have represented this sphere on the ceiling of an Egyptian temple, without knowing that it represented a state of the heavens which no lon-

---

* Description of the Pyramids of Ghiza, by M. Grobert, p 117.

ger existed [*]. This, as is seen, was a conclusion very different from that of Mr Burkhard. Dupuis was the first who thought it necessary to search for proofs of the idea, in some measure confidently adopted, that it was the solstice that was denoted. He found them, with reference to the great zodiac of Dendera, in the globe on the top of the pyramid, and in several emblems placed near different signs, and which he imagined, sometimes according to the opinion of ancient authors, such as Plutarch, Horus Apollo, or Clement of Alexandria, sometimes according to his own conjectures, ought to be regarded as representing phenomena which had been really those of the seasons affected at each sign. As for the rest, he maintained that this state of the heavens affords the date of the monument, and that it is the original, and not a copy, of the sphere of Eudoxus, that was represented at Dendera, which would refer it to a period of 1468 years before Christ, or to the reign of Sesostris. The number of nineteen boats, however, placed under each band, furnished him with the idea that the solstice might probably have been at the nineteenth degree of the sign, which would make it 288 years older [†].

---

[*] Connaissance des Temps for the year xiv.

[†] Observations upon the zodiac of Dendera, in the Revue Philosophique et Litteraire, 1806, p. 257, *et seq*.

Mr Hamilton * having remarked, that, at Dendera, the Scarabæus belonging to the side of the ascending signs is smaller than that of the other side, an English author † has concluded from this that the solstice may have been nearer its actual point than the middle of the Cancer, which would carry us back to a period of 1000 or 1200 years before Christ.

The late M. Nouet, judging that the globe, the rays, and the horned head, or head of Isis, represent the heliacal rising of Sirius, supposed that it was intended to mark an epoch of the Sothian period, but that it was intended to mark it by the place which the solstice occupied. Now, in the last but one of these periods, that which elapsed between 2782 and 1322 before Christ, the solstice had passed from 30° 48′ of the constellation of the Lion to 13° 34′ of Cancer. At the middle of this period, it was therefore at 23° 34′ of cancer. The heliacal rising of Sirius happened then some days after the solstice; and this is nearly what has been indicated, according to M. Nouet, by the re-

---

* Ægyptiaca, p. 212.

† See in the British Review of February 1817, p. 13. *et seq.* the article No. vi. upon the origin and antiquity of the zodiac. It is translated at the end of Swartz's Critical Letter upon the Zodiacomania.

petition of the Scarabæus, and by the figure of Sirius with the rays of the sun placed at the commencement of the band to the right. Calculating upon this basis, he concludes that the temple of Dendera was built 2052 years before Christ, and that of Esne 4600 *.

All these calculations, even admiting that the division marks the solstice, would still be susceptible of many modifications; and, at first, it appears that their authors have supposed the constellations all of thirty degrees like the signs, and have not reflected that it is far from being the case that they are thus equal, at least as they are represented at the present day, and as the Greeks have transmitted them to us. In reality, the solstice, which is at present on this side of the first stars of the constellation of Gemini, could only have left the first stars of the constellation of Cancer forty-five years before Christ, and had left the constellation of Leo only 1260 years before the same era.

◆

My distinguished and learned colleague, M. Delambre, has favoured me with the following table and remarks, which illustrate what has been above said.

---

* See M. Nouet's Memoir in Volney's New Inquiries regarding Ancient History, vol. iii. p. 328–336.

TABLE of the Extent of the Zodaical Constellations, as they are designed upon our Globes, and of the Times required by the Colures to traverse them.

Stars.	Longitudes in 1800.				Year of the Equinox.	Year of the Solstice.
ARIES.						
γ	1_s	0°	23′	40″	—389	6869
β	1	1	10	40	—441	6921
α	1	4	52	0	—710	7190
η	1	5	18	50	—742	7222
2 θ	1	6	14	16	—810	7290
ζ	1	19	8	50	—1739	8219
τ tail.	1	20	51	0	—1862	8342
Dur.		20	27	20	1473	1473
TAURUS.						
ξ	1^s	19°	6′	0″	—1735	—8215
η	1	27	12	0	—2318	—8798
α	2	6	59	40	—3024	—9504
β	2	19	47	0	—3944	—10424
ζ	2	22	0	0	—4104	—10584
a Coch.	2	24	42	40	—4300	—10780
Dur.		35	36	40	2565	2565
GEMINI.						
Propus.	2^s	28°	9′	20″	—4547	—11027
η	3	0	39	0	—4727	—11207
γ	3	6	18	40	—5134	—11614
δ	3	15	44	0	—5813	—12293
Castor.	3	17	27	30	—5937	—12417
Pollux.	3	20	28	9	—6154	—12634
φ	3	22	27	10	—6926	—12776
Dur.		24	17	40	1749	1749

Stars.	Longitudes in 1800.				Year of the Equinox.	Year of the Solstice.
			CANCER.			
1 ω	3^{s}	24°	21′	55″	6475	+45
ζ	3	28	32	0	6734	—254
β	4	1	28	20	6906	—426
γ	4	4	45	0	7182	—702
1 α	4	10	18	50	7583	—1103
2 α	4	10	50	36	7621	—1141
κ	4	13	23	0	7804	—1324
Dur.		19	1	5	1369	1369
			LEO.			
κ	4^{s}	12°	30′	0″	—7740	—1260
α	4	27	3	10	—8788	—1908
δ	5	8	30	0	—9612	—3132
β	5	18	50	55	—10357	—3877
...	..	...	...	...	......	......
...	..	...	...	...	......	......
Dur.		36	20	55	2617	2617
			VIRGO.			
ω	5^{s}	19°	2′	22″	—10371	—3891
β	5	24	19	0	—10750	—4271
η	6	2	2	40	—11307	—4827
δ	6	8	41	40	—11786	—5306
α	6	21	3	15	—12676	—6196
λ	7	4	9	50	—13620	—7140
μ	7	7	17	40	—13845	—7365
Dur.		48	15	18	3474	3474
Mean Dur.		30	0	0	2160	

Stars.	Longitudes in 1800.				Year of the Equinox.	Year of the Solstice.
Libra.						
1 α	7^{s}	11°	0′	44″	—14113	—7633
2 α	7	12	18	0	—14246	—7926
β	7	16	35	0	—14514	—8034
γ	7	22	20	34	—14929	—8449
γ Scorp.	7	27	41	0	—15312	—8832
ξ	7	28	30	15	—15372	—8892
...	..	...	...	...	......	......
Dur.		17	29	31	1259	1259
Scorpio.						
I A	7^{s}	28°	50′	6″	—15396	—8916
β	8	0	23	48	—15508	—9028
α	8	6	57	38	—15980	—9500
ζ	8	12	35	30	—16387	—9907
λ	8	21	47	27	—17049	—105569
...	..	...	...	...	......	......
Dur.		22	57	21	1653	1653
Sagittarius.						
γ	7^{s}	28°	28′	20″	—17530	—11050
λ	9	3	32	56	—17895	—11415
ζ	9	10	50	28	—18421	—11941
ψ	9	14	15	15	—18667	—12187
ω	9	23	2	19	—19299	—12819
g	9	25	39	25	—19487	—13007
...	..	...	...	...	......	......
Dur.		27	11	50	1957	1957

Stars.	Longitudes in 1800.				Year of the Equinox.	Year of the Solstice.
			CAPRICORN.			
1α	9ˢ	29°	39′	15″	—19775	—13295
2α	10	1	3	58	—19877	—13397
β	10	1	15	30	—19891	—13411
ι	10	14	53	30	—20872	—14392
γ	10	18	59	28	—21166	—14586
μ	10	23	1	12	—21458	—14978
ν	...	...	...	...	......	......
Dur.		23	21	17	1683	1683
			AQUARIUS.			
ε	10ˢ	8°	56′	0″	—20444	—13964
β	10	20	36	30	—21285	—14805
α	11	0	34	0	—22001	—15521
ζ	11	6	7	0	—22400	—15920
2 ψ	11	13	56	12	—22963	—16483
5 A	11	18	3	28	—23260	—16780
Dur.		39	7	28	2816	2816
			PISCES.			
β	11ˢ	15°	49	0″	23095	16615
λ	11	23	49	0	23675	17195
δ	12	11	22	0	24939	18459
σ	12	24	26	0	25879	19399
α	12	26	34	58	26034	19554
	...	...	...	...	......	.... .
	...	...	...	...	......	......
Dur.		40	45	58	2939	2939
Sirius	3	11	20	10	0° —5487	270° —18447

Construction and Use of the Table.

"The longitudes of the stars, for 1800, have been taken from the Berlin Tables, and are those of Lacaille, Bradley, or Flamstead. The first and the last of each constellation have been taken, as well as some of the brightest of the intermediate stars. The third column indicates the year in which the longitude of the star was 0′, that is to say, that in which the star was in the equinoxial colure of spring. The last column indicates the year when the star was in the solstitial colure, whether of winter or of summer.

"For Aries, Taurus, and Gemini, the winter solstice has been chosen; for the other constellations the summer solstice has been chosen, for the sake of not receding into too remote antiquity, and of not approaching too near modern times. It will be easy to find the opposite solstice, by adding the semiperiod of 12,960 years. The same rule will serve for finding the time when the star has been, or will be, at the autumnal equinox.

"The sign — indicates the years before our era, the sign + the year of our era; and the last line, at the end of each sign under the title of *duration*, gives the extent of the constellation in degrees, and the time which the equinox, or the solstice, occupies in traversing the constellation from one end to the other.

"The precession of 50″ yearly has been supposed, this being the result of the comparison of the catalogue of Hipparchus with the modern catalogues. We have thus the advantage of round numbers, and a general accuracy that may be relied upon. The entire period is thus 25,920 years; the semiperiod, 12,960 years; the quarter period, 6480 years; the twelfth, or a sign, 2160 years.

"It is to be remarked, that the constellations leave empty spaces between them, and that sometimes they encroach upon each other. Thus, between the last star of Scorpio, and the first of Sagittarius, there is an interval of 6⅔ degrees. On the other hand, the last of Capricorn is more advanced by 14° in longitude, than the first of Aquarius. Hence, even independently of the inequality of the sun's motion, the constellations would afford a very unequal and very erroneous measure of the year and its months. The signs of 30° furnish a more convenient and less defective one. But the signs are merely a geometrical conception; they can neither be distinguished nor observed; and they are continually changing place from the retrogradation of the equinoxial point.

"We have at all times been able to determine, in a rough manner, the equinoxes and solstices;

at the long run it has been remarked, that the appearance of the heavens was no longer exactly the same that it anciently was at the times of the equinoxes and solstices. But we have never been able to observe exactly the heliacal rising of a star, being always necessarily some days wide of it; and people frequently speak of it, without possessing a fixed datum on which to count. Before Hipparchus, we find nothing, either in books or in traditions, that can be submitted to calculation; and it is this which has given rise to so many systems. Controversies have arisen without a sufficient knowledge of the subject. Those who are not astronomers may form ideas as beautiful as they please of the knowledge of the Chaldeans, Egyptians, &c.; no real inconvenience will result. The enterprise and knowledge of the moderns may be lent to these nations, but nothing can be borrowed from them; for they have either had nothing, or they have left nothing. Astronomers will never derive from the ancients any thing that can be of the slightest utility. Let us leave to the learned their vain conjectures, and confess our utter ignorance respecting things of little use in themselves, and of which no monument remains.

"The limits of the constellations vary according to the authors which we consult. We find these limits extend or contract, as we pass from Hipparchus to Tycho, from Tycho to Hevelius, from Hevelius to Flamstead, Lacaille, Bradley, or Piazzi.

"I have said elsewhere, the constellations are good for nothing, unless at the most to enable us to mark the stars with more ease; whereas the stars in particular afford fixed points to which we can refer the motions, whether of the colures or of the planets. Astronomy commenced only at the period when Hipparchus made the first catalogue of the stars, measured the revolution of the sun, that of the moon, and their principal inequalities. The rest presents nothing but darkness, uncertainty, and gross error. The time would be lost that were occupied in attempting to reduce this chaos to order.

"I have given, with the exception of a few particulars, the whole of my opinion on this subject. I am nowise anxious about making converts, for it gives me little concern whether my ideas be adopted or not; but, if my reasons be compared with the reveries of Newton, Herschell, Bailly, and so many others, it is not impossible but that, in time, these more or less brilliant chimeras will no longer be relished.

"I have attempted to determine the extent of the constellations, according to the catasterisms of Eratosthenes; but the thing is really impossible. The matter would be still worse were we to consult Hygin, and especially Firmicus. The following is what I have made out from Eratosthenes.

CONSTELLATIONS.	DURATIONS.	CONSTELLATIONS.	DURATIONS.
	Years.		Years.
Aries,	1747	The Talons,	1089 *
Taurus,	1826	Scorpio,	1823
Gemini,	1636	Sagittarius,	2138
Cancer,	1204	Capricorn,	1416
Leo,	2617	Aquarius,	1196
Virgo,	3307	Pisces,	2936

"As to the Chaldeans, Egyptians, Chinese, and Indians, there is no want of reveries among them. One can absolutely make nothing of them. My opinion with regard to them may be seen in the preliminary discourse of my History of the Astronomy of the Middle Age, p. xvii and xviii. See also the note affixed to the Report on the Memoirs of M. de Paravey, vol. viii. of the Nouvelles Annales des Voyages, and republished by M. de Paravey in his Summary of his Memoirs upon the Origin of the Sphere, p. 24, 31–36. See further

---

* Eratosthenes has made but one constellation of the Scorpion and Talons. He indicates the commencement of the latter without its termination; and as he gives 1823 years to Scorpio, properly so called, there remain 1089 for the other, on the supposition that there is not an empty space between these two constellations.

the Analysis of the Mathematical Labours of the Academy in 1820, p. 78 and 79.

" DELAMBRE."

It would still have to be ascertained at what period the observers ceased to place the constellation in which the sun entered after the solstice, at the head of the descending signs, and whether this was done as soon as the solstice had retrograded sufficiently to touch the preceding constellation.

Thus MM. Jollois and Devilliers,—to whose unremitting zeal we are indebted for an accurate knowledge of these famous monuments, always considering the division towards the entrance of the porch as the solstice, and judging that the Virgin must have been regarded as the first of the descending constellations, insomuch as the solstice had not receded at least so far as the middle of the constellation of the Lion; and, believing that they saw farther, as we have mentioned, that the Lion is divided in the great zodiac of Esne,—have not given to that zodiac a more remote antiquity than 2160 years before Christ.*

Mr Hamilton, who was the first that observed this division of the sign of the Lion, in the zodiac of Esne, reduced the distance of the period at which the solstice occurred there, to 1400 years before Christ. A great many other opinions have appeared on the same subject. M. Rhode, for example, has proposed two. The first refers the zodiac of the portico of Dendera to a period of 591 years before Christ; the second, to 1290[*]. M. Latreille has fixed the period of this zodiac at 670 years before Christ; that of the planisphere at 550; that of the zodiac of the great temple of Esne at 2550; and that of the small one at 1760.

---

* See the great work on Egypt. Antiq. Mem. vol. i. p. 486.

But a difficulty inherent in all the dates, which proceed on the double suppositon, that the division marks the solstice, and that the position of the solstice marks the epoch of the monument, is the unavoidable consequence that the zodiac of Esne must have been at least 2000, and perhaps 3000, years[†] older than that of Dendera, a consequence which evidently involves the supposition in ruin; for no one, in any degree acquainted with the history of the arts, could believe, that two edifices, so similar in their style of architecture, could have been erected at periods so remote from each other.

---

[*] Rhode. Essay upon the Age of the Zodiac, and the Origin of the Constellations, in German. Breslau, 1809, p. 78.

[†] According to the tables of M. Delambre's note above, the solstice has remained 3474, or at least 3307 years, in the constellation of virgo, the one which occupies the greatest space in the zodiac, and 2617 in that of the Lion.

The feeling of this impossibility, joined always to the belief that this division of the zodiacs indicates a date, has given rise to another conjecture, namely, that the intention had been to mark the particular sacred year of the Egyptians, in which the monument had been erected. As these sacred years consisted only of 365 days, if the sun, at the commencement of one occupied the commencement of a constellation, he would be nearly six hours later in returning to the commencement of the following year, and, after 121 years, he would only be at the commencement of the preceding sign. It seems natural enough that the builders of a temple might wish to indicate about what period of the great, or Sothian year, it had been erected; and the indications of the sign, by which the sacred year then commenced, was a good enough means. It will be perceived, that, calculating upon this assumption, there will be an interval of from 120 to 150 years between the temple of Esne and that of Dendera. But, in his mode of solving the problem, there remained to be determined in which of the great years these buildings had been erected, whether in that which ended in the year 138 after, or in that which ended in 1322 before Christ, or in some other.

The late Visconti, who was the first author of this hypothesis, taking the sacred year, whose commencement corresponded with the sign of the Lion, and judging from the resemblance of the signs, that they had been represented at a period when the opinions of the Greeks were not unknown to the Egyptians, was naturally led to make choice of the end of the last great year, or the space that elapsed between the year 12 and the year 138 after Christ *, which appeared to him to accord with the Greek inscription, of which, however, he knew little more than that it was said to make mention of one of the Cæsars.

M. Testa, seeking the date of the monument in another order of ideas, went so far as to suppose that since the Virgin is seen at Esne, at the head of the zodiac, it was meant thereby to represent the era of the battle of Actium, such as it had been established with regard to Egypt, by a decree of the senate, mentioned by Dion Cassius, and which commenced in the month of September, the day on which Alexandria was taken by Augustus.†

---

* Translation of Herodotus by Larcher, vol. ii. p. 570.

† See the Dissertation of the Abbé Dominique Testa, Sopra due Zodiaci novellamente scoperte nell' Egitto, Rome, 1802, p. 34.

M. de Paravey considered these zodiacs in a new point of view, which embraced at once both the revolution of the equinoxes, and that of the great year. Supposing that the circular planisphere of Dendera must have been set to the east, and that the axis from north to south is the line of the solstices, he found the summer solstice at the second of the Twins, and that of winter at the buttock of the Sagittary, while the line of the equinoxes would have passed through the Fishes and the Virgin, from which he obtained for date the first century of our era.

According to this method, the division of the zodiac of the portico could no longer refer to the colures, and the mark of the solstice must be sought for elsewhere. M. de Paravey having remarked that there are between all the signs figures of women bearing a star upon their heads, and marching in the same direction, and observing that the one which comes after the twins, is alone turned in a direction contrary to the others, judged that it indicates the *conversion* of the sun or the tropic, and that this zodiac corresponds in this way with the planisphere.

By applying the idea of easting to the small zodiac of Esne, the solstices would be found bebetween the Twins and the Bull, and between the Scorpion and Sagittary; they would even be marked by the change of direction of the Bull, and by the winged Rams placed across at these two places. In the great zodiac of the same city, the marks would be the cross position of the Bull, and the reversed one of the Sagittary. There would thus be but a portion of a constellation traversed between the dates of Esne and those of Dendera, but even this would be still too long for buildings so closely resembling each other.

An operation of the late M. Delambre upon the circular planisphere appears to confirm these conjectures, detracting from its remote antiquity; for, on placing the stars upon Hipparchus's projection, according to the theory of that astronomer, and according to the positions which he has given them in his catalogue; and augmenting all the longitudes, so that the solstice might pass through the second of the Twins, he nearly reproduced this planisphere; and "the resemblance," says he, "would have been still greater, had the longitudes been adopted such as they are in the catalogue of Ptolemy, for the year 123 of our era. On the contrary, by referring to twenty-five or twenty-six centuries back, the right ascensions and the declinations will be considerably changed, and the projection will assume quite a different figure *. All our calculations,"

---

* Delambre. Note at the end of the Report on the

adds this great astronomer, “lead us to this conclusion, that the sculptures are posterior to the epoch of Alexander.”

In reality, the circular planisphere having been brought to Paris by the care of MM. Saunier and Lelorrain, M. Biot, in a work founded upon precise measurements and calculations full of ingenuity, has determined that it represents, according to an exact geometrical projection, the state of the heavens, such as it was 700 years before Christ; but he by no means concludes that it had been sculptured at that period .

In fact, all these efforts of intellect and science, in so far as they concern the epoch of the monuments, have become superfluous, since finishing where they should naturally have begun, if the first observers had not been blinded by prejudice, people have taken the trouble of copying and restoring the Greek inscriptions engraved upon these monuments, and especially since M. Champollion has discovered the method of decyphering those which are expressed in hieroglyphics.

Memoir of M. de Paravey. This report is printed in the Nouvelles Annales des Voyages, vol. viii.

[*] See the work of M. Biot, entitled, Recherches sur plusieurs points de l'Astronomie Egyptienne, appliquées aux monumens astronomiques trouvés en Egypte ; Paris, 1823, 8vo.

It is now certain, and the Greek inscriptions agree with the hieroglyphical inscriptions in proving it,—it is certain, we say, that the temples in which zodiacs have been sculptured, were built during the time when Egypt was subject to the Romans. The portico of the temple of Dendera, according to the Greek inscription of its frontispiece, is consecrated to the safety of Tiberius *. On the planisphere of the same temple we read the title of *Autocrator* in hieroglyphical characters †; and it is probable that it refers to Nero. The small temple of Esne, that of which the origin has been placed on the lowest calculation between 2700 and 3000 years before Christ, has a column sculptured and painted in the sixth year of Antonine, 147 years after Christ, and it is painted and sculptured in the same style as the zodiac which is near it ‡.

Further, we have a proof that this division of the zodiac, in such or such sign, has no reference to the precession of the equinoxes, or to the displacement of the solstice. A mummy case, lately brought from Thebes by M. Caillaud, and containing, according to the very legible Greek inscription upon it, the body of a young man who died in the ninth year of Trajan, 116 years after Christ [*], presents a zodiac divided at the same point as those of Dendera [†]; and all the appearances indicate that this division marks some astrological theme relative to the individual,—a conclusion which may probably be equally applied to the division of the zodiacs contained in the temples. It may mark either the astrological theme of the time of their erection, or that of the prince to whose safety they had been consecrated, or such another epoch with relation to which the position of the sun would have appeared of importance to be noticed.

---

* Letronne. Researches into the history of Egypt during the domination of the Greeks and Romans, p. 180.

† Id. ibid. p. xxxviij.

‡ Letronne. Ibid. p. 456, and 457.

Thus are dissipated for ever the conclusions which people had drawn from some ill explained monuments, against the newness of the continents and nations; and we might have dispensed with treating of them so much in detail had they not been so recent, and had they not made sufficient impression still to retain their influence over the minds of some individuals.

---

[*] Letronne. Critical and Archæological Observations upon the object of the zodiacal representations which remain to us of antiquity, occasioned by an Egyptian zodiac painted in a mummy case, which bears a Greek inscription of the time of Trajan; Paris, 1824, 8vo, p. 30.

[†] Idem, p. 48, and 49.

The Zodiac is far from bearing in itself a certain and excessively remote date.

But there are writers who have maintained that the zodiac bears in itself the date of its invention, because the names and figures given to its constellations are an index of the position of the colures at the time when it was invented; and this date, according to several, is so evident and so remote, that it is quite a matter of indifference whether the representations which we possess of this circle are more or less ancient.

They do not attend to the circumstance that, in this sort of argument, there is a complication of three suppositions equally uncertain: the country in which the zodiac is presumed to have been invented, the signification which is supposed to have been given to the constellations which occupy it, and the position in which the colures were with relation to each constellation, when this signification was attributed to it. According as other allegories have been imagined, or as these allegories are admitted to have referred to the constellation of which the sun occupied the first degrees, or to that of which it occupied the middle, or to that into which it began to enter, that is to say, of which it occupied the last degrees;

or, lastly, to that which was opposite to him, and which rose at night; or according as the invention of these allegories is placed in a different climate, must the date of the zodiac also be changed. The possible variations in this respect might comprehend so much as the half of the revolution of the fixed stars, that is to say, 13,000 years, and even more.

In this manner Pluche, generalizing some indications of the ancients, has imagined, that the Ram announces the commencement of the sun's elevation, and the vernal equinox; that the Cancer indicates his retrogradation to the summer solstice; that the Balance, the sign of equality, marks the autumnal equinox *; and that the Capricorn, a climbing animal, indicates the winter solstice, after which the sun returns to us. According to this method, by placing the inventors of the zodiac in a temperate climate, we should have rains under Aquarius, the dropping of lambs and kids under the Gemini, violent heats under the Lion, gathering of the harvest under the Virgin, the time of hunting under the Sagittary, &c.; and the emblems would be appro-

---

* Varro, de Ling. Lat. lib. vi. Signa, quod aliquid significent, ut libra æquinoctium; Macrob. Sat. lib. i. cap. xxi. Capricornus ab infernis partibus ad superas solem reducens Capræ naturam videtur imitari.

priate enough. If we should then place the colures at the commencement of the constellations, or at least the equinox at the first stars of Aries, we should, in the first instance, arrive at a period of only 389 years before Christ, an epoch evidently too modern, and which would render it necessary to recur to a complete equinoxial period, or 26,000 years. But if the equinox be supposed to pass through the middle of the constellation, a period of about 1000 or 1200 years higher is obtained, 1600 or 1700 years before Christ; and this is what several celebrated men have believed to be the true epoch of the invention of the zodiac, the honour of which they have, for other reasons not sufficiently weighty, conferred upon Chiron.

But Dupuis, who required for the origin which he endeavoured to attribute to all religions, that astronomy, and, in particular, the figures of the zodiac should in some measure have preceded all other human institutions, has sought another climate for the purpose of finding other explanations for the emblems, and for that of deducing another epoch from them. If, assuming the Balance as an equinoxial sign, but supposing it at the vernal equinox, it be presumed that the zodiac has been invented in Egypt, other sufficiently plausible explanations might in fact be found for the climate of that country.* The Capricorn, an animal with the tail of a fish, would mark the commencement of the rise of the Nile at the summer solstice; the Aquarius and Fishes, the progress and diminution of the inundation; the Bull, the time of labouring; the Virgin, the time of reaping; and they would mark them at the periods when these operations actually took place. In this system, the zodiac would have 15,000 years† for a sun supposed at the first degree of each sign, more than 16,000 for the middle, and 4000 only, on supposing that the emblem has been given to the sign at the opposite of which the sun was‡. It is to the 15,000 years that Dupuis has attached himself; and it is upon this date that he has founded the whole system of his celebrated work.

There are not wanting those, however, who, admitting that the zodiac has been invented in Egypt, have imagined allegories applicable to later times. Thus, according to Mr Hamilton, the Virgin would represent the land of Egypt when not yet fecundated by the inundation; the

---

* See the Memoir on the Origin of the Constellations, in Dupuis's Origine des Cultes, vol. iii. p. 324. *et seq.*

† Id. ibid. p. 267.

‡ Dupuis himself suggests this second hypothesis. Ibid. p. 340.

Lion, the season when that country is most liable to be overrun by ferocious animals, and so on*.

The high antiquity of 15,000 years would besides induce this absurd consequence, that the Egyptians, those men who represented every thing by emblems, and who must have attached a great importance to the circumstance that these emblems were conformable to the ideas which they were intended to represent, had preserved the signs of the zodiac thousands of years after they no longer in any way corresponded with their original signification.

The late M. Remi Raige endeavoured to support the opinion of Dupuis by an argument of an entirely new kind †. Having remarked that significations more or less analogous to the figures of the signs of the zodiac, might be found for the Egyptian names of the months, on explaining them by the oriental languages, and finding in Ptolemy that *epifi*, which signifies *capricorn*, commences at the 20th of June, and therefore comes immediately after the summer solstice, he concluded from thence, that, at the beginning, Capricorn itself was at the summer solstice, and so of the other signs, as Dupuis had supposed.

---

* Ægyptiaca, p. 215.

† See in the Great Work on Egypt, Antiq. Mem. vol. i., the memoir of M. Remi Raige upon the nominal and original zodiac of the ancient Egyptians. See also the table of the Greek, Roman, and Alexandrian months, in M. Halma's Ptolemy, vol. iii.

But, independently of all that there is merely conjectural in these etymologies, Raige did not perceive that it was simply by chance that, five years after the battle of Actium, in the year 25 before Christ, at the establishment of the fixed year of Alexandria, the first day of *Thoth* was found to correspond with the 29th of the Julian August, and continued to correspond since that time. It is only from this epoch that the Egyptian months commenced at fixed days of the Julian year, and only at Alexandria: even Ptolemy did not the less continue to employ in his Almagest the ancient Egyptian year with its vague months*.

Why might not the names of the signs have been given to the months at some epoch, or the names of the months to the signs, in the same arbitrary manner in which the Indians have given to their twenty-seven months twelve names, selected from among those of their lunar houses, for reasons which it is impossible at the present day to determine*? The absurdity which there would have been in preserving for the constellations, during 15,000 years, figures and symbolical names which no longer presented any relation with their position, would have been more evident had it been carried so far as to preserve to the months those same names which were incessantly in the mouths of the people, and whose inaptitude would be every moment perceived.

---

* See the Historical Researches regarding the Astronomical Observations of the ancients, by M. Ideler, a translation of which has been inserted by M. Halma in the third volume of his Ptolemy: and especially M. Freret's memoir on the opinion of Lanauze, relative to the establishment of the Alexandrian year, in the memoirs of the Academy of Belles Lettres, vol. xvi. p. 308.

And what, besides, would all these systems come to, had the figures and the names of the zodiacal constellations been given to them without any relation to the course of the sun; as their inequality, the extension of several of them beyond the zodiac, and their manifest connection with the neighbouring constellations, seem to demonstrate was the case†.

What would still happen, if, as Macrobius expressly says ‡, each sign must have been an emblem of the sun, considered in some one of its effects or of its general phenomena, and without reference to the months when it passes, whether into the sign, or to its opposite?

---

* See the Memoir of Sir William Jones on the Antiquity of the Indian Zodiac. Calcutta Memoirs, vol. ii.

† See the Zodiac explained, or Researches regarding the Origin and Signification of the Constellations of the Greek Sphere, translated from the Swedish of M. Swartz; Paris, 1809.

‡ Saturnalia, lib. i. cap. xxi. sub. fin. *Nec solus Leo,*

Lastly, What if the names had been given in an abstract manner to the divisions of space or time, as they are now given by astronomers to what they call the signs, and had not been applied to the constellations or groups of stars, but at a period determined by chance, so that nothing could be concluded from their signification[*]?

In these suggestions there is, without doubt, enough to give an ingenuous mind a distaste for seeking to find in astronomy proofs of the antiquity of the nations. But were these alleged proofs as certain as they are vague and destitute of any satisfactory result, what could be concluded from them against the great catastrophe, which has left monuments amply demonstrative in other

---

sed signa quoque universa zodiaci ad naturam solis jure referuntur, &c. It is only in the explanation of the Lion and Capricorn, that he has recourse to some phenomenon relative to the seasons; the Cancer itself is explained in a general point of view, and with reference to the obliquity of the sun's march.

[*] See the Memoir of M. Guignes on the Zodiacs of the Eastern Nations, in the Memoirs of the Academy of Belles Lettres, vol. xlvii.

respects of its existence? All that can be admitted in this matter is, what some moderns have thought, that astronomy was among the number of the sciences preserved by those whom this catastrophe dispersed.

Exaggerations relative to the Antiquity of certain Mining Operations.

The antiquity of certain mining operations has also been much exaggerated. A very late writer has imagined, that the mines of the island of Elba, judging from the rubbish carried out of them, must have been wrought for more than 40,000 years; but another author, who has also examined this rubbish with attention, has reduced the period in question to a little more than 5000 years, * and this even on the supposition that the ancients did not extract annually more than a fourth part of the quantity of ore now wrought. But what reason could there be to suppose that the Romans, for example, who consumed so much iron in their armies, derived so little advantage from these mines? Moreover, if these mines had been wrought for even 4000 years only, how should iron have been so little known in the times of remote antiquity?

---

* See M. de Fortia d'Urban's History of China before the Deluge of Ogyges, p. 33.

General Conclusion relative to the Period of the last Revolution.

I agree, therefore, with MM. Deluc and Dolomieu, in thinking, that if any thing in geology be established, it is, that the surface of our globe has undergone a great and sudden revolution, the date of which cannot be referred to a much earlier period than five or six thousand years ago; that this revolution overwhelmed and caused to disappear the countries which were previously inhabited by man, and the species of animals now best known; that, on the other hand, it laid dry the bottom of the last sea, and formed of it the countries which are at the present day inhabited; that it is since the occurrence of this revolution that the small number of individuals dispersed by it have spread and propagated over the newly exposed lands, and, consequently, that it is since this epoch only, that human societies have assumed a progressive march, that they have formed establishments, raised monuments, collected natural facts, and invented scientific systems.

But the countries which are at present inhabited, and which the last revolution laid dry, had already been previously inhabited, if not by men, at least by land animals, and, therefore, one preceding revolution at least had put them under water; and if we may judge by the different orders of animals the remains of which are observed in them, they had perhaps been subjected to two or three irruptions of the sea.

Further Researches to be made in Geology.

These alternations now appear to me to form the problem in geology that it is of most importance to solve, or rather to define and circumscribe within due limits; for, in order to resolve it satisfactorily, it would be necessary to discover the cause of these events,—an undertaking which presents a difficulty of quite a different kind.

I repeat it, we see pretty clearly what is going on at the surface of the continents in *their present* state; we have formed a tolerable conception of the uniform progress and regular succession of the primitive formations, but the study of the secondary formations has been little more than merely commenced. That wonderful series of unknown zoophytes and marine mollusca, succeeded by reptiles and fresh-water fishes equally unknown; and these again replaced, in their turn, by other zoophytes and mollusca, more nearly related to those of the present day; those land animals, and those equally unknown fresh water mollusca and other animals which next occupied

e surface, to be again displaced but by mol-
sca and other animals similar to those of our
esent seas; the relations of these diversified be-
gs to the plants the remains of which accompany
eirs, the connection of these two kingdoms with
e mineral strata in which they are deposited;
e greater or less uniformity existing between
ese different orders of beings in the different
sins;—these are phenomena which appear to
imperiously to demand the attention of philo-
phers.

Rendered interesting by the variety of the pro-
cts of the partial or general revolutions of this
och, and by the abundance of the various species
at figure alternately on the stage, this study is
vested of the dryness of that of the primordial
mations, and does not, like it, almost necessa-
y launch into hypotheses. The facts are so
ect, so curious, and so evident, that they are
fficient, so to speak, to satisfy the most ardent
agination; and the conclusions to which they
d from time to time, however scrupulous the
server may be, having nothing vague in them,
equally free of any thing arbitrary. In fine,
is in those events that approach nearer to our
n times, that we may hope to find some traces
more ancient events, and of their causes; if,
leed, after so many fruitless attempts as have
en already ma[illegible], one may be permitted to flat-
himself with such a hope.

These ideas have haunted, I may almost say have tormented me, during my researches among fossil bones, the results of which I have lately presented to the public; researches which embrace but a very small part of those phenomena of the age preceding the last general revolution of the globe, and which are yet intimately connected with all the others. It was almost impossible that the desire should not arise of investigating the general mass of these phenomena, at least as they occur in a limited space around us. My excellent friend, M. Brongniart, in whose mind other studies excited the same desire, had the complaisance to associate me with himself in the task; and it is thus that we have laid the first foundations of our labours upon the environs of Paris. But this work, while it still bears my name, has become almost entirely that of my friend, from the infinite attention which he has bestowed, since the first conception of our plan, and since our journeys, upon the profound investigation of the objects, and the perfecting and arranging of the whole. I have placed it, with M. Brongniart's consent, in the second part of my "Recherches," in that in which I treat of the fossil bones of our neighbourhood. Although apparently relating only to a rather limited extent of country, it affords numerous results, which are applicable to geology in general, and, in this point of view, it may be considered as intimately connected with the present discourse; at the same time, that it is, without a doubt, one of the best ornaments of my work [*].

In it there is presented the history of the most recent changes that have taken place in a particular basin, and it descends so far as the Chalk formation, the extent of which over the globe is vastly more considerable than that of the materials of the basin of Paris. The chalk, which has been considered so modern, is thus found to be advanced in antiquity among the ages of the great period preceding the last catastrophe. It forms a sort of limit between the most recent formations, those to which the name of *Tertiary* may be reserved, and the formations which are named *Secondary*, which have been deposited before the Chalk, but after the Primitive and Transition formations.

Recapitulation of the Observations upon the Succession of the Tertiary Formations.

The most superficial strata, those deposits of mud and clayey sand, mixed with rolled pebbles, that have been transported from distant countries, and filled with bones of land animals, the species of which are for the most part unknown, or at least foreign to the country in which they are found, seem especially to have covered all the plains, filled the bottom of all the caverns, and choked up all the fissures of rocks that have come in their way. Described with particular care by Mr Buckland, under the name of *diluvium*, and very different from those other beds equally consisting of transported matters, continually deposited by torrents and rivers, which contain only bones of animals that still live in the country, and distinguished by the name of *alluvium*, the former are now considered by all geologists as exhibiting the most obvious proof of the immense inundation which has been the last of the catastrophes of our globe *.

---

[*] Copies have been printed separately, under the title of *Description Geologique des Environs de Paris,* par MM. G. Cuvier et Al. Bro[illegible]iart. Second edition. Paris, 1822, 4to.

Between this diluvium and the chalk, are the formations alternately filled with fresh water and salt water productions, which mark the irruptions and retreatings of the sea, to which this part of the globe has been subjected, since the deposition of the chalk-strata: first, marls and buhrstones, or cavernous quartz, filled with fresh-water shells, similar to those of our marshes and pools; under them marls, sandstones, and limestones, all the shells of which are marine, such as oysters, &c.

---

* See Professor Buckland's work, entitled *Reliquiæ Diluvianæ*. Lond. 1823, 4to, p. 185 et seq.; and the article *Eau*, by M. Brongniart, in the 14th volume of the *Dictionnaire des Sciences Naturelles*.

At a greater depth are found fresh water formations of an older date, and particularly those famous gypsum deposits of the neighbourhood of Paris, which have afforded so much facility in ornamenting the buildings of that great city, and in which we have discovered whole genera of land-animals, of which no traces had been elsewhere perceived.

They rest upon those not less remarkable beds of limestone, of which our capital is built, in the more or less compact texture of which the patience and sagacity of our naturalists, and of several ardent collectors, have already detected more than 800 species of shells, all of them marine, but the greater part unknown in the presently-existing sea. They also contain only bones of fishes, and of cetacea and other marine mammifera.

Under this marine limestone there is another fresh water deposit, formed of clay, in which there are interposed large beds of lignite (brown coal), or that sort of fossil-coal which is of more recent origin than the common or black coal. Among shells, which are always of fresh water origin, there are also found bones in the deposit; but, what is remarkable, bones of reptiles, and not of mammifera. It is filled with crocodiles and tortoises, but the genera of extinct mammifera which the gypsum contains, are not found in it: they evidently did not exist in the country when these clays and lignites were formed.

This fresh water formation, the oldest which has been distinguished in our neighbourhood, and which supports all the formations which we have just enumerated, is itself supported and embraced on all sides by the chalk, an immense formation, both as to thickness and extent, which shews itself in very distant countries, such as Pomerania and Poland; but which, in our vicinity, reigns with a sort of continuity in Berri, Champagne, Picardy, Upper Normandy, and a part of England, and thus forms a great circle, or rather a great basin, in which the deposits of which we have been speaking are contained, but of which they also cover the edges in the places where they were less elevated.

In fact, it is not in our basin only that these various formations have been deposited. In the other countries where the surface of the chalk presented similar cavities for them; in those even where there was no chalk, and where the older formations alone presented themselves as supports, circumstances often led to the formation of deposits more or less similar to ours, and containing the same organic bodies.

Our formations containing fresh-water shells, have been seen in England, in Spain, and even so far as the confines of Poland.

The marine shells interposed between them, have been found along the whole course of the Appenines.

Some of the quadrupeds of our gypsum deposits, our palæotheria, for example, have also left their bones in certain gypseous formations of the Velai, and in the molasse quarries of the south of France.

Thus the partial revolutions which have taken place in our neighbourhood, between the period of the chalk and that of the great inundation, and during which the sea threw itself upon our districts or retired from them, had also taken place in a multitude of other countries. It seems as if the globe had undergone a long series of changes by which variations were produced, probably in close succession, as the deposits which they have left nowhere shew much thickness or solidity. The chalk has been produced by a more tranquil and more continuous sea; it contains only marine productions, among which there are, however, some very remarkable vertebrate animals, but all of the class of reptiles and fishes; large tortoises, vast lizards, and other similar animals.

The formations anterior to the chalk, and in the hollows of which the chalk is itself deposited, as the formations of our neighbourhood are in its hollows, form a great part of Germany and England; and the efforts which the naturalists of these two countries have recently made according with ours, and proceeding upon the same principles, combined with those which had been previously tried by the school of Werner, will soon leave nothing to be desired with respect to our knowledge of them. Messrs de Humboldt and de Bonnard in France and Germany, and Messrs Buckland and Conybeare in England, have furnished the most complete and most instructive accounts of them.

◆

The subjoined table, in which not only the secondary formations have been arranged, but the whole series of strata, from the oldest known to the most modern and most superficial, has been politely furnished me by M. de Humboldt, to adorn my work. It may be considered as an epitome of the labours of geologists up to the present period *.

---

* A full view of the arrangement of rocks is given in note O.

TABLE of Geological Formations in the order of their superposition. By M. Al. de Humboldt.

Alluvial Deposits.		*Tertiary Formations.*
Lacustrine Formation with Buhrstones.		
Fountainbleau sandstone and sand.		
Gypsum with bones.	Siliceous Limestone.	
Coarse Limestone. (London Clay.)		
Tertiary sandstone with lignites.		
(Plastic clay,—Molasse,—Nagelfluhe.)		
Chalk. white. tufaceous. chloritic.	*Ananchites.*	*Secondary Formations.*
Green sand. Weald clay. Iron Sand.	(Secondary Sandstone with *lignites.*)	
Ammonites. *Planulites.* Jura Limestone.	Slaty beds with fishes and crustacea.	
Quadersandstein, or white sandstone, sometimes above the lias.	Coral rag. Dive clay. Oolites and Caen limestone. Marly or calcareous lias with *Gryphæa arcuata.*	
Muschelkalk. *Ammonites nodosus.*		
Marls with fibrous gypsum. Arenaceous beds.	Saliferous variegated sandstone.	
Productus aculeatus. Magnesian limestone. Zechstein. Copper slate.	(Alpine limestone.)	
Quartziferous Porphyry.	Co-ordinate formations of porphyry, red sandstone, and coal.	
Transition Formations. Slates with Lydian-stone, greywacke, diorites, euphotides. Limestones with orthoceratis, trilobites and euomphalites.		*Transition Formations.*
Primitive Formations. Clayslates (Thonschiefer). Micaslates. Gneiss. Granites.		*Primitive Formations.*

Under the chalk are found deposits of green sand, of which its lower strata contains some organic remains. Beneath this are ferruginous sands. In many countries both of these deposits are agglutinated into beds of sandstone, in which lignites, amber, and remains of reptiles, are also observed.

Under this, we find the great mass of strata which compose the Jura chain, and that of the mountains by which it is continued into Suabia and Franconia, the principal ridges of the Apennines, and multitudes of beds in France and England. It consists of limestone-schists, rich in fishes and crustacea; vast beds of oolites, or of a granular limestone; grey marly limestones, with pyrites, characterised by the presence of ammonites, of oysters with recurvate valves, named Gryphææ, and of reptiles, which are remarkable on account of their forms and structures.

Large beds of sand and sandstone, often presenting vegetable impressions, support all these Jura deposits, and are themselves supported by a limestone, the innumerable shells and zoophytes contained in which induced Werner to give it the much too general name of *Shell-limestone*, and which is separated by other beds of sandstone, of the kind denominated *variegated* sandstone, from a still older limestone, which has been not less improperly called *Alpine limestone*, because it composes the High Alps of the Tyrol; but which also shews itself at the surface in the eastern provinces of France, and in the whole southern part of Germany.

In this shell-limestone are deposited great masses of gypsum and rich beds of salt; and under it are found the thin beds of copper-slates so rich in fishes, among which there are also fresh-water reptiles. The copper-slate rests upon a red sandstone, to the epoch of which belong those famous deposits of coal, which supply the present inhabitants of the civilized countries of Europe with fuel, and are the remains of the first vegetable productions with which the face of the globe was adorned. We learn from the trunks of ferns, whose impressions they have preserved, how different these ancient forests have been from ours.

We then quickly come to those transition formations, in which primeval nature, nature dead and purely mineral, seems to have disputed the empire with organising nature. Black limestones, and schists which present only crustacea and shells of kinds now extinct, alternate with remains of primitive formations, and announce our having arrived at those formations, the oldest with which we are acquainted, those ancient foundations of the present envelop of the globe, the marbles and primitive slates, the gneisses, and, lastly, the granites.

Such is the precise enumeration of the successive masses with which nature has enveloped the globe. The positive geological information presented by it, has been obtained, by combining the knowledge furnished by mineralogy with that presented by the sciences connected with organic existence. This order, so new and so interesting in facts, has only been acquired by geology, since it preferred positive knowledge, furnished by observation, to fanciful systems, contradictory conjectures regarding the first origin of the globe, and all those phenomena, which, having no resemblance to what actually takes place in nature, could neither find in it, for their explanation, materials nor touchstone. A few years ago, the greater number of geologists might have been compared to historians, who, in writing the history of France, should have interested themselves only about the events which had taken place among the Gauls before the time of Julius Cesar. In composing their romances, however, these historians would have taken advantage of their knowledge of posterior facts; and the geologists of whom I speak, absolutely neglected the posterior facts, which could alone have reflected some light upon the darkness of preceding times.

Enumeration of the Fossil Animals recognised by the Author.

In concluding this discourse, there only remains for me now to present the result of my own researches, or, in other words, a general account of my great work. I shall enumerate the animals which I have discovered, in the inverse order of that which I have followed in my enumeration of the formations. By proceeding deeper and deeper into the series of strata, I there rose in the series of epochs. I shall now take the oldest formations, —make known the animals which they contain, —and, passing from one epoch to another, point out those which successively make their appearance in proportion as we approach the present time.

We have seen that zoophytes, mollusca, and certain crustacea, begin to appear in the Transition formations; perhaps there may even at that period be bones and skeletons of fishes; but we do not by any means observe at so early a period remains of animals which live on land, and respire air in its ordinary state.

The great beds of coal, and the trunks of palms and ferns of which they preserve the impressions, although they afford evidence of the existence of dry land, and of a vegetation no longer confined to the waters, do not yet shew bones of quadrupeds, not even of oviparous quadrupeds.

It is only a little above this, in the bituminous copper-slates, that we see the first traces of them; and, what is very remarkable, the first quadrupeds are reptiles of the family of lizards, very much resembling the large monitors which live at the present day in the torrid zone. Several individuals of this kind have been found in the mines of Thuringia*, among innumerable fishes of a genus now unknown, but which, from its relations to the genera of our days, appears to have lived in fresh water. Every body knows that the monitors are also fresh water animals.

A little higher is the limestone called Alpine, and resting upon it the shell-limestone, so rich in entrochites and encrinites, which forms the basis of a great part of Germany and Lorraine.

In it have been found skeletons of a very large sea-tortoise, the shells of which might have been from six to eight feet in length; and those of another oviparous quadruped of the family of lizards, of a large size, and with a very sharp muzzle†.

Rising still through sandstones, which present only vegetable impressions of large arundinaceæ, bamboos, palms, and other monocotyledonous plants, we come to the different strata of the deposit which has been named the Jura limestone, on account of its forming the principal nucleus of that chain of mountains.

---

* See my "Recherches sur les Ossemens Fossiles," t. v. part ii. p. 300.

† Id. vol. v. part ii. p. 355 and 525.

It is here that the class of Reptiles assumes its full development, and shews itself under the most varied forms and gigantic sizes.

The middle part, which is composed of oolites and lias, or of grey sandstone containing gryphites, contains the remains of two genera, the most extraordinary of all, which have combined the characters of the class of oviparous quadrupeds with organs of motion similar to those of the cetacea.

The *ichthyosaurus* *, discovered by Sir Everard Home, has the head of a lizard, but prolonged into an attenuated muzzle, armed with conical and pointed teeth; enormous eyes, the sclerotica of which is strengthened by a frame consisting of bony pieces; a spine composed of flat vertebræ, of a depressed circular form, and concave on both surfaces like those of fishes; slender ribs; a sternum and clavicles like those of lizards and ornithorynchi; a small and weak pelvis; and four limbs, of which the humeri and femurs are short and thick, while the other bones are flattened, and closely set like the stones in a pavement, so as to form, when enveloped with the skin, fins of a single piece, almost incapable of bending; analogous, in short, both as to use and organization, to those of cetacea. These reptiles have lived in the sea; on shore, they could only at most have crept in the hobbling manner of seals; at the same time after they have respired elastic air.

---

* See my "Recherches," vol. v. part ii. p. 447.

The remains of four species have been found:

The most extensively distributed (*I. communis*) has blunt conical teeth; its length sometimes exceeds twenty feet.

The second (*I. platyodon*), which is at least as large as the former, has compressed teeth, with round and bulging roots.

The third (*I. tenuirostris*), has slender and pointed teeth, and the muzzle thin and elongated.

The fourth (*I. intermedius*), is, as its name implies, intermediate between the last species and the common, with respect to the form of its teeth. The two latter species do not attain half the size of the two first.

The *plesiosaurus*, discovered by Mr Conybeare, must have appeared still more monstrous than the ichthyosaurus. It had the same limbs, but somewhat more elongated and more flexible; its shoulder and pelvis were more robust; its vertebræ had more of the forms and articulations of the lizards; but what distinguished it from all oviparous and viviparous quadrupeds, was a slender neck as long as its body, composed of thirty and odd vertebræ, a number greater than that of the neck of any other animal, rising from the trunk like the body of a serpent, and terminating in a very small head, in which all the essential characters of that of the lizard family are observed.

If any thing could justify those hydras and other monsters, the figures of which are so often presented in the monuments of the middle ages, it would incontestibly be this plesiosaurus. *

Five species are already known, of which the most generally distributed (*P. dolichodeirus*) attains a length of more than twenty feet.

A second species (*P. recentior*), found in more modern strata, has the vertebræ flatter.

A third (*P. carinatus*) shews a ridge on the under surface of its vertebræ.

A fourth, and lastly a fifth (*P. pentagonus* and *P. trigonus*), have the ribs marked with five and three ridges. †

These two genera are found everywhere in the lias: they were discovered in England, where this rock is exposed in cliffs of great extent; but they have also been found since in France and Germany.

---

* Researches, &c. vol. v. part ii. p. 475. *et seq.*

† Researches, vol. v. part ii. p. 485 and 486.

Along with these had lived two species of Crocodiles, the bones of which are also found deposited in the lias, among ammonites, terebratulæ, and other shells of that ancient sea. We have skeletons of them in our cliffs at Honfleur, where the remains are found, from which I have drawn up their characters.†

One of these species, the *Long-beaked Gavial*, has the muzzle longer, and the head more narrow, than the gavial or long-beaked crocodile of the Ganges; the bodies of its vertebræ are convex before, while in our crocodiles of the present day they are so behind. It has been found in the lias deposits of Franconia, as well as in those of France.

A second species, the *Short-beaked Gavial*, has the muzzle of ordinary length, less attenuated than the gavial of the Ganges, but more so than our crocodiles of St Domingo. Its vertebræ are slightly concave at each of their extremities.

But these crocodiles are not the only ones which have been deposited in the strata of these secondary limestones.

---

* Researches, vol. v. part ii. p. 143.

beautiful oolite quarries of Caen have
d a very remarkable one, the muzzle of
as long and more pointed than that of
-beaked gavial, and its head more dilated
with wider temporal fossæ. Its stony
narked with small round cavities, must
ıdered it the best defended of all the croco-
Its lower teeth are alternately longer and

is still another in the oolite of England;
e have only been found some portions of
um, which do not suffice to afford a com-
ea of it. †

her very remarkable genus of reptiles, the
of which, although they are also found
the limits of the lias concretion, are espe-
undant in the oolite and upper sands, is
galosaurus, justly so named, for, along
forms of the lizards, and particularly of
nitors, of which it has also the sharp-
nd dentated teeth, it presents so enormous
hat if we suppose it to have possessed the
ons of the monitors, it must have exceeded
feet in length. It was, in fact, a lizard

---

arches, vol. v. part ii. p. 127.

expect a fuller knowledge of it from M. Cony-
searches.

of the size of a whale. * It was discovered by Mr Buckland in England; but we have it also in France; and in Germany there are found bones, if not of the same species, at least of a species which can be referred to no other genus. It is to M. Sœmmering that we owe the first description of this last. He discovered the bones in strata lying above the oolite, in those limestone-schists of Franconia, long celebrated for the numerous fossil remains which they furnished to the cabinets of the curious, and which will be still more celebrated for the services which their employment in lithography render to the arts and sciences.

The crocodiles continue to make their appearance in these schists, and always of the long-muzzled or rostrated kind. M. de Sœmmering has described one (the *Crocodilus priscus*), the entire skeleton of a small individual of which was found nearly in as good a state of preservation, as it could have been in our cabinets. † It is one of those which most resemble the present gavial of the Ganges; the anterior or united part of its lower jaw, however, is less elongated; its lower teeth are alternately and regularly longer and shorter. It has ten vertebræ in the tail.

---

* Researches, vol. v. part ii. p. 343.

† Ibid. p. 120.

But the most remarkable animals which these limestone slates contain, are the flying lizards, which I have named *Pterodactyli*.

They are reptiles whose principal characters are, a very short tail, a very long neck, the muzzle much elongated, and armed with sharp teeth; the legs also long, and one of the toes of the anterior extremity excessively elongated, having probably served for the attachment of a membrane adapted for supporting them in the air, accompanied with four other toes of ordinary size, terminated by hooked claws. One of these strange animals, whose appearance would be frightful did they occur alive at the present day, may have been of the size of a thrush*, the other of that of a common bat†; but it would appear from some fragments that larger species had existed ‡.

A little above the limestone slates is found the nearly homogeneous limestone of the Jura ridges. It also contains bones, but always of reptiles, crocodiles, and fresh-water tortoises, of which a vast quantity is found in particular in the neighbourhood of Soleure. They have been very carefully searched for by M. Hugi; and, from the fragments which he has already collected, it is easy to recognise a considerable number of Fresh-water Tortoises, or Emydes, which further discoveries can alone determine, but of which several are already distinguished by their size and peculiar forms, from all the species hitherto known *.

---

* Researches, vol. v. part ii. p. 358. *et seq.*

† Ibid. p. 376. ‡ Ibid. p. 380.

It is among these innumerable oviparous quadrupeds, of all sizes and forms; in the midst of these crocodiles, tortoises, flying reptiles, huge megalosauri, and monstrous plesiosauri, that some small Mammifera are said to make their appearance for the first time; and the assertion is so far authenticated by the occurrence of jaws, and some other bones discovered in England, which undoubtedly belong to this class of animals, and particularly to the family of Didelphides, or to that of the Insectivora.

It may, however, be supposed, that the stoney matters which encrust these bones, owe their origin to some local recomposition, posterior to the original formation of the strata. However this may be, it is still found for a long time that the class of Reptiles predominates.

The ferruginous sands, placed in England above the chalk, contain abundance of crocodiles, tortoises, megalosauri, and especially a reptile

---

* Researches, vol. v. part ii. p. 225.

which presents a character quite peculiar, in as much as its teeth appear worn, like those of our herbivorous mammifera.

To Mr Mantell of Lewes, in Sussex, we are indebted for the discovery of this latter animal, as well as of other large reptiles belonging to the sands lying beneath the chalk. He has named it *Iguanodon*.

In the chalk itself there are only reptiles to be seen: there are found in it remains of tortoises and crocodiles. The famous tufaceous quarries of the mountain of St Peter, near Maestricht, which belong to the chalk formation, along with very large sea tortoises, and a multitude of marine shells and zoophytes, have afforded a genus of lizards not less gigantic than the megalosaurus, which has become celebrated by the researches of Camper, and the figures which Faujas has given of its bones, in his history of that mountain.

It was upwards of five and twenty feet long; its large jaws were armed with very strong conical teeth, a little arcuate, and marked with a ridge, and it had also some of these teeth in the palate. Upwards of a hundred and thirty vertebræ were counted in its spine; they were convex before, and concave behind. Its tail was deep and flat, and formed a large vertical oar (or organ of swimming).[*] Mr Conybeare has recently proposed to name it *Mosasaurus*.

---

* Researches, vol. v. part ii. p. 161, 232, and 350.

The clays and lignites which cover the upper part of the chalk, I have only found to contain crocodiles[†]; and I have every reason to think that the lignites which in Switzerland have afforded beaver and mastodon bones, belong to a later epoch. Nor has it been at an earlier period than that of the coarse limestone which rests upon these clays that I have begun to find bones of mammifera; and still do they all belong to marine mammifera, to dolphins of unknown species, lamantins and morses.

Among the dolphins, there is one, the muzzle of which, more elongated than that of any known species, has the lower jaw united in a considerable part of its length, nearly as in a gavial. It was found near Dax by the late president of Borda[‡].

Another species, from the cliffs of the Department de l'Orne, has the muzzle also long, but somewhat differently shaped[§].

The entire genus of lamantins is at the present

Researches, vol. v. part iv. p. 310, *et seq.*

[†] Ibid. p. 163.

[‡] Ibid. p. 316.

[§] P. 317.

day confined to the seas of the torrid zone; and that of the morses, of which only a single living species is known to exist, is limited to the frozen ocean. Yet we find skeletons of these two genera side by side in the coarse limestone strata of the middle of France; and this association of species, the nearest allied to which are, at the present day, found in opposite zones, will again make its appearance more than once as we proceed.

Our fossil lamantins differ from those known to exist at present, in having the head more elongated, and of a different form [*]. Their ribs, which are easily recognised by their being of a thick and rounded form, and of dense texture, are not of rare occurrence in our different provinces.

With regard to the fossil morse, small fragments only have as yet been found of it, which are insufficient for characterising the species [†].

It is only in the strata that have succeeded the coarse limestone, or, at most, those which may have been of contemporaneous formation with it, but deposited in fresh-water lakes, that the class of land mammifera begins to shew itself in any quantity.

I consider as belonging to the same period, and as having lived together, but perhaps in different spots, the animals whose bones are deposited in the molasse and old gravel beds of the south of France; in the gypsums mixed with limestone, such as those of Paris and Aix; and in the fresh-water marly deposits covered with marine beds, of Alsace, the country of Orleans and of Berry.

---

[*] Researches, vol. v. part ii. p. 266.

[†] Id. vol. v. part i. p. 234; and part ii. p. 521.

This animal population possesses a very remarkable character in the abundance and variety of certain genera of pachydermata, which are entirely awanting among the quadrupeds of our days, and whose characters have more or less resemblance to those of the tapirs, the rhinoceroses, and camels.

These genera, the entire discovery of which is my own, are the *palæotheria, lophiodonta, anaplotheria, anthracotheria, cheropotami,* and *adapis.*

The *Palæotheria* have resembled the tapirs in their general form, and in that of the head, particularly in the shortness of the bones of the nose, which announces that they have had a small proboscis like the tapirs, and, lastly, in their having six incisors and two canine teeth in each jaw; but they have resembled the rhinoceros in their grinders, of which those of the upper jaw have been square, with prominent ridges of various configuration, and those of the lower jaw in the form of double crescents, as well as in their feet, all of which have been divided into three toes, while in the tapirs the fore feet have four.

It is one of the most extensively diffused genera and most numerous in species that occur in the deposits of this period.

Our gypsum quarries in the neighbourhood of Paris are full of them. Bones of seven distinct species are found there. The first *(P. magnum)* is as large as a horse. The three next are of the size of a hog, but one of them *(P. medium)* has narrow and long feet, another *(P. crassum)* has the feet broader, and a third *(P. latum)* has them still broader, and especially shorter. The fifth species *(P. curtum)*, which is of the size of a sheep, is much lower, and has the feet still broader and shorter in proportion than the last. The sixth *(P. minus)* is of the size of a small sheep, and has long and slender feet, the lateral toes of which are shorter than the rest. The seventh *(P. minimum)*, which is not larger than a hare, has also the feet slender *.

Palæotheria have also been found in other districts of France: at Puy in Valey, in strata of gypseous marl, a species *(P. velaunum)* †, much resembling *(P. medium)*, but differing from it in the form of its lower jaw; in the neighbourhood of Orleans, in strata of marly rock, a species *(P. aurelianense)*[*], which is distinguished from the others by having the re-entering angle of the crescent of its lower grinders split into a double point, and by some differences in the necks of the upper grinders; near Issel, in a bed of gravel or molasse, along the declivities of the Black Mountain, a species *(P. isselanum)*[†], which has the same characters as the Orleans species, but is of smaller size. It is more particularly, however, in the molasse of the Department of the Dordogne, that the palæotherium occurs not less abundantly than in our gypsum deposits in the neighbourhood of Paris.

---

* See my Researches, in the whole of vol. iii., and especially p. 250; and vol. v. part ii. p. 505.

† Ibid. vol. v. part ii. p. 505.

The Duke Decaze has discovered in the quarries of a single field, bones of three species which appear different from all those of our neighbourhood[‡].

The *Lophiodons* approach still somewhat nearer to the tapirs than the palæotheria do, inasmuch as their lower false grinders have transverse necks like those of the tapirs.

---

[*] Researches, vol. iii. p. 254; and vol. iv. p. 498. and 499.

[†] Ibid. vol. iii. p. 258.

[‡] Ibid. vol. v. part ii. p. 505.

differ, however, from these latter, in ha-
fore ones more simple, the backmost of all
ee necks, and the upper ones rhomboidal,
ked with ridges very much resembling
the rhinoceros.

re still ignorant what the form of their
d the number of their toes, may have been.
iscovered not less than twelve species of
us, all in France, deposited in marly rocks
water formation, and filled with lymneæ
orbes, which are shells peculiar to pools
shes.

largest species is found near Orleans, in
quarry as the palæotheria; it approaches
oceros.

is a smaller species in the same place; a
urs at Montpellier; a fourth near Laon;
Buchsweiler in Alsace; five near Ar-
n Berry; and one of the three occurs
ar Issel, where there are also two others.
also a large one near Gannat *.

species differ from each other in size, the
being scarcely so large as a lamb of three
and in various circumstances connected

---

y Researches, vol. ii. part i. p. 177 and 218; vol.
; and vol. iv. p. 498.

with the form of their teeth, which it would be too tedious and minute to detail here.

The *Anoplotheria* have hitherto been discovered nowhere but in the gypsum quarries of the neighbourhood of Paris. They have two characters which are observed in no other animal; feet with two toes, the metacarpal and metatarsal bones of which are separate in their whole length, and do not unite into a single piece, as in the ruminantia; and teeth placed in a continuous series without any interruption. Man alone has the teeth so placed in mutual contiguity, without any interval. Those of the anaplotheria consist of six incisors in each jaw, a canine tooth and six grinders on each side, both above and below; their canine teeth are short and similar to the outer incisors. The three first grinders are compressed; the four others are, in the upper jaw, square, with transverse ridges, and a small cone between them; and, in the lower jaw, in the form of a double crescent, but without neck at the base. The last has three crescents. Their head is of an oblong form, and does not indicate that the muzzle has terminated either in a proboscis or a snout.

This extraordinary genus, which can be compared to nothing in living nature, is subdivided into three subgenera: the *Anaplotheria*, properly so called, the anterior molares of which are still pretty thick, and the posterior ones of the lower jaw have their crescents with a simple ridge; the *Xiphodons*, of which the anterior molares are thin and sharp on the edges, and the under posterior, have, directly opposite the concavity of each of their crescents, a point, which, on being worn, also assumes the form of a crescent, so that then the crescents are double as in the ruminantia; lastly, the *Dichobunes*, the outer crescents of which are also pointed at the beginning, and which have thus points disposed in pairs upon their lower posterior grinders.

The most common species in our gypsum quarries (*An. commune*), is an animal of the height of a boar, but much more elongated, and furnished with a very long and very thick tail, so that altogether it has nearly the proportion of the otter, but larger. It is probable that it was well fitted for swimming, and frequented the lakes in the bottom of which its bones have been incrusted by the gypsum which was deposited there. We have one a little smaller, but in other respects pretty similar (*An. secundarium.*)

We are as yet acquainted with only one *xiphodon*, which, however, is a very remarkable animal: it is that which I have named *An. gracile.* It is slender, and delicately formed, like the prettiest gazelle.

There is one *dichobune*, nearly of the size of a hare, to which I have given the name of *An. le-*

porinum. Besides its subgeneric characters, it differs from the anaplotheria and xiphodons, in having two small and slender toes on each foot, at the sides of the two large toes.

We do not know if these lateral toes exist in the two other dichobunes, which are small, and scarcely exceed in size the common Guinea pig*.

The genus of *Anthracotheria* is in some degree intermediate between the palæotheria, anaplotheria, and hogs. I have named it so, because two of its species have been found in the lignites of Cadibona, near Savone. The first approached the rhinoceros in size; the second was much smaller. They have also been found in Alsace, and in the Vélay. Their grinders are similar to those of the anaplotheria; but they have projecting canine teeth †.

The genus *Cheropotamus* is found in our gypsum deposits, where it accompanies the palæotheria and anaplotheria, but where it is of much rarer occurrence. Its posterior grinders are square above, rectangular below, and have four large conical eminences surrounded with smaller ones.

---

* Regarding the Anaplotheria, see the whole of the 3d volume of my "Researches," and particularly p. 250 and 396.

† "Researches," vol. iii. p. 398 and 404; vol. iv. p. 501; vol. v. part ii. p. 506.

1

The anterior molares are short cones, slightly compressed, and with two roots. Its canine teeth are small. Neither its incisors nor its feet are yet known. I possess only one species, which is of the size of a Siam hog*.

The genus *Adapis* has also but one species, which is at most of the size of a rabbit: it is also from our gypsum quarries, and must have been nearly allied to the anaplotheria†.

We have thus nearly forty species of pachydermata belonging to genera now entirely extinct, and presenting forms and proportions to which there is nothing that can be compared in the present animal kingdom, excepting two tapirs and a daman.

This large number of pachydermata is so much the more remarkable, that the ruminantia, which are at present so numerous in the genera of deer and antelopes, and which attain so great a size in those of the oxen, giraffes, and camels, scarcely make their appearance in the deposits of which we are speaking.

I have not seen the slightest trace of them in our gypsum quarries; and all that has come to my hands consists of some fragments of a deer, of the size of the roe, but of a different species, collected among the palæotheria of Orleans*; and of one or two other small fragments, from Switzerland, which, however, are perhaps of doubtful origin.

---

* "Researches," vol. iii. p. 260.

† Id. vol. iii. p. 265.

But our pachydermata have not for all this been the only inhabitants of the countries in which they lived. In our gypsum deposits, at least, we find along with them carnivora, glires, several sorts of birds, crocodiles, and tortoises; and these two latter genera also accompany them in the molasse sandstones and marly deposits of the middle and south of France.

At the head of the carnivora, I place a Bat, very recently discovered at Montmartre, and which belongs to the proper genus Vespertilio †. The existence of this genus, at an epoch so remote, is so much the more surprising, that, neither in this formation, nor in those which have succeeded it, have I seen any other trace, either of cheiroptera or of quadrumana: no bone or tooth of either monkey or maki has ever presented itself to me, in the course of my long researches.

---

* "Researches," vol. iv. p. 103.

† I am indebted for the knowledge of this animal to the Count de Bournon; and as I have not described it in my great work, I have given a figure of it here. See Plate II. figs. 1 and 2.

Montmartre has also furnished the bones of a fox different from ours, and which also differs from the jackals, isatises, and the various species of foxes peculiar to America[*]; those of a carnivorous animal allied to the racoons and coaties, but larger than any known species[†]; those of a particular species of civet[‡]; and of two or three other carnivora, which it has not been possible to determine, from the want of tolerably complete portions.

What is still more remarkable, is, that there are skeletons of a small sarigue, allied to the marmose, but different, and consequently of an animal belonging to a genus which is at the present day confined to the New World[§]. Skeletons of two small glires, of the genus myoxus[||], and a skull belonging to the genus sciurus[¶], have also been collected.

Our gypsum deposits are more fertile in bones of birds than any of the other strata either anterior or posterior to it. Entire skeletons, and parts of at least ten species belonging to all the orders, are found there [*].

---

[*] "Researches," vol. iii. p. 267.

[†] Id. vol. iii. p. 269.

[‡] Id. vol. iii. p. 272.

[§] Id. vol. iii. p. 284.

[||] Id. vol. iii. p. 297 and 300.

[¶] Id. vol. v. part ii. p. 506.

The crocodiles of the period in question approach our common crocodiles in the form of the head, while, in the deposits of the Jura period, we find only species allied to the gavial.

A species has been found at Argenton, which is remarkable for its compressed, sharp teeth, having their edges dentated like those of certain monitors [†]. Some remains of it also occur in our gypsum quarries [‡].

The tortoises of this period are all fresh-water ones: some of them belong to the subgenus *Emys;* and there are species, both at Montmartre [§], and still more especially in the molasse sandstones of the Dordogne [||], which are larger than any living species known; the others are Trionyces or soft tortoises [¶]. This genus, which is easily distinguished by the vermiculate surface of the bones of its shell, and which at present exists only in the rivers of warm countries, such as the Nile, the Ganges, and the Orinoko, has been very abundant in the places where the palæotheria lived. Vast quantities of its remains are found at Montmartre *, and in the molasse sandstones of the Dordogne, and the other gravel deposits of the south of France.

---

[*] "Researches," vol. iii. p. 304 *et seq.*

[†] Id. vol. v. part ii. p. 166.

[‡] Id. vol. iii. p. 335; vol. v. part ii. p. 166.

[§] Id. vol. iii. p. 233.

[||] Id. vol. v. p. 232.

[¶] Id. vol. iii. p. 329; vol. v. part ii. p. 222.

The fresh-water lakes, around which these various animals have lived, and which had received their bones, nourished, besides the tortoises and crocodiles, some fishes and testaceous mollusca. All that have been collected of these two classes of animals, are as foreign to our climate, and even as much unknown in our present waters, as the palæotheria, and other quadrupeds which were coeval with them †.

The fishes have even in part belonged to unknown genera.

Hence, it cannot be doubted that this race of inhabitants, which might be termed the population of the middle age, this first great production of mammifera, has been entirely destroyed ; and, in fact, in all places where remains of them have been discovered, there are great deposits of marine formation above them, so that the sea has overwhelmed the countries which these races inhabit-

---

* "Researches," vol. v. part ii. p. 223 and 227.

† Id. vol. iii. p. 338.

ed, and has rested upon them during a long period of time.

Have the countries inundated by it at this period been of great extent? This is a question which the examination of those ancient deposits formed in their lakes do not enable us to answer.

To this period I refer the gypsum beds of Paris and those of Aix, several quarries of marly stones, and the molasse sandstones, at least those of the south of France. I am of opinion that we should also refer to it the portions of the molasse sandstones of Switzerland, and of the lignites of Liguria and Alsace, in which quadrupeds are found of the families enumerated above; but I do not find that any of these animals have been also found in other countries. The fossil bones of Germany, England, and Italy, are all either older or newer than those of which we have been speaking, and belong either to those ancient races of reptiles of the juraic and copper-slate formations, or to the deposits of the last universal inundation, the diluvial formations.

We are, therefore, authorised to believe, until the contrary be proved, that at the period when these numerous pachydermata lived, the globe had only presented for their habitation a small number of plains sufficiently fertile for them to multiply there, and that perhaps these plains were insulated regions, separated by pretty large spaces of elevated chains, in which we do not find that our animals have left any traces of their existence.

The researches of M. Adolphe Brongniart have also made known to us the nature of the vegetables which covered those countries. In the same strata with our palæotheria, there have been found trunks of palms, and many others of those beautiful plants whose genera now only grow in warm climates. Palms, crocodiles, and trionyces always occur in greater or less abundance wherever our ancient pachydermata are found *.

The sea which had covered these lands and destroyed their animals, left large deposits, which still form at the present day, at no great depth, the basis of our great plains: it had then retired anew, and left immense surfaces to a new populaion, whose remains are found in the sandy and muddy deposits of all countries known.

It is to this deposition from the sea, made in a tate of quiet, that certain fossil cetacea, very much resembling those of our own days, should, n my opinion, be referred;—a dolphin, allied to our epaulard †, and a whale very like our rorquals ‡, both discovered in Lombardy by M. Cor-

---

* See my "Researches," vol. iii. p. 351. *et seq.*

† Id. vol. v. part i. p. 309. ‡ Id. p. 390.

tesi; a large head of a whale found within the very precincts of Paris *, and described by Lamanon and Daubenton; and an entirely new genus, which I have discovered and named *Ziphius*, and which already contains three species. It is allied to the cachalots and hyperoodons †.

In the extinct population which fills our alluvial and superficial strata, and which has lived upon the deposit just alluded to, there are no longer either palæotheria or anaplothæria, or, in in fact, any of those singular genera. The pachydermata, however, still predominate; and these are of a gigantic size, elephants, rhinoceroses, and hippopotami, accompanied with innumerable horses and several large ruminantia. Carnivorous animals of the size of the lion, tiger, and hyena, had desolated this new animal kingdom. In general, its character, even in the extreme north, and on the edges of the present frozen ocean, was similar to that which the torrid zone alone now presents, and yet there was no species in it absolutely the same as any of those which are found alive at the present day.

The most remarkable of these animals is the species of elephant named *mammoth* by the Russians (the *Elephas primigenius* of Blumenbach), which was fifteen or eighteen feet high, and was covered with coarse red wool, and long, stiff, black hairs, which formed a mane along its back. Its enormous tusks were implanted in alveolæ longer than those of the elephants of the present day; but in other respects it was pretty similar to the Indian elephant*. It has left thousands of its carcases from Spain to the shores of Siberia, and it has been found in the whole of North America; so that it had been distributed on both sides of the Atlantic, if, indeed, that ocean had existed in its time, in the place which it occupies at present. It is well known that its tusks are still so well preserved in cold countries, as to be applied to the same uses as fresh ivory; and, as we have already remarked, individuals of it have been found with their flesh, skin, and hair, which had remained frozen since the last general catastrophe. The Tartars and Chinese have imagined it to be an animal which lives under ground, and perishes whenever it perceives the light.

---

* "Researches," vol. v. part i. p. 393.

† Id. vol. v. part i. p. 352. and 357.

After the mammoth, and almost its equal in size, came also in the countries which form the two presently existing continents, the *narrow toothed mastodon*, which resembled the elephant, and was armed like it with enormous tusks, but with tusks covered with enamel, shorter legs, and whose mamillated grinders, invested with a thick and shining enamel, have long furnished what has been called occidental turquoise *.

---

* "Researches," vol. i. p. 75, 195 and 335; vol. iii. p. 371 and 405; vol. iv. p. 491.

Its remains, which are pretty common in the temperate parts of Europe, are not so much so towards the north; but it has also been found in the mountains of South America, along with two allied species.

In North America immense quantities of the remains of the *great mastodon* have been found, a species larger than the preceding, as high in proportion as the elephant, with equally huge tusks, and whose grinders, which are covered over with bristling points, made it long be considered as a carnivorous animal †.

Its bones were of a large size, and very solid. Even its hoofs and stomach are said to have been found in a sufficient state of preservation to be recognisable; and it is asserted that the stomach was filled with bruised branches of trees. The Indians imagine that the whole race was destroyed by the gods, to prevent them from destroying the human species.

---

* "Researches," vol. i. p. 250, 265 and 335; vol. iv. p. 493.

† Id. vol. i. p. 206, 249; vol. iii. p. 376.

Along with these enormous pachydermata, lived the two somewhat inferior genera of the rhinoceroses and hippopotami.

The Hippopotamus of this period was pretty common in the countries which now form France, Germany and England, and was particularly so in Italy. It so closely resembled the present African species, that it is only by an attentive comparison that it can be distinguished from it *.

There was also at this time a small species of hippopotamus of the size of the wild boar, to which there is nothing similar at present existing.

There were at least three species of Rhinoceros of large size, all of them two-horned.

The most common species in Germany and England (my *Rh. tichorhinus*), and which, like the elephant, is found even to the shores of the frozen sea, where it has also left entire individuals, had the head elongated, the bones of the nose very robust and supported by an osseous and not merely cartilaginous septum narium, and, lastly, wanted incisors †.

---

* "Researches," vol. i. p. 304, 322; vol. iii. p. 380; vol. iv. p. 493.

† Id. vol. ii. part i. p. 64; and vol. iv. p. 496.

Another species, of rarer occurrence, and peculiar to more temperate climates *(Rh. incisivus)* *, had incisors like our present rhinoceroses of the East Indies, and, in particular, resembled that of Sumatra †; its distinctive characters are derived from some differences in the form of the head.

The third species (*Rh. leptorhinus*) had no incisors, like the first and like the present rhinoceros of the Cape; but it was distinguished by a more pointed muzzle and more slender limbs ‡. The bones of this species have been found more especially in Italy, in the same strata with those of elephants, mastodons, and hippopotami.

There is a fourth species still (*Rh. minutus*), furnished, like the second, with incisors, but of a much smaller size, and scarcely larger than a hog ||. It was undoubtedly rare, for the remains of it have only as yet been found in some places in France.

To those four genera of large pachydermata, is added a Tapir, which equalled them in size, and was consequently twice, perhaps three times, as

---

* "Researches," vol. ii. part i. p. 89. vol. iii.; p. 390; and vol. v. part ii. p. 50.

† Id. vol. iii. p. 385.

‡ Id. vol. ii. part i. p. 71.

|| Id. vol. ii. part i. p. 89.

large in its linear dimensions as the American Tapir [*]. Its teeth have been found in several parts of France and Germany; and almost always accompanying those of rhinoceroses, mastodons, or elephants.

Along with these there is still associated, but as it would seem in a very small number of places, a large pachydermatous animal, of which the lower jaw alone has been found, and whose teeth are of the form of double crescents, and undulated. M. Fischer, who discovered it among bones from Siberia, has named it *Elasmotherium*[†].

The Horse genus also existed in those times[‡]. Its teeth accompany in thousands the remains of the animals which we have just mentioned, in almost all their localities; but it is not possible to say whether it was one of the species now existing or not, because the skeletons of these species are so like each other, that they cannot be distinguished by the mere comparison of isolated fragments.

The Ruminantia were now greatly more numerous than at the epoch of the Palæotheria; their numerical proportion must even have differed very little from what it is at present; but we are certain of several species which were different.

---

[*] See my "Researches," vol. part i. p. 89.

[†] Id. p. 95.

[‡] Id. p. 109.

This may, in particular, be said with much certainty of a deer exceeding even the elk in size, which is common in the marl deposits and peat-bogs of Ireland and England, and of which remains have also been dug up in France, Germany, and Italy, where they were found in the same strata with bones of elephants. Its wide, palmated, and branched horns, measure so much as twelve or fourteen feet from one point to the other, following the curvatures *.

The distinction is not so clear with regard to the bones of deer and oxen, which have been collected in certain caverns, and in the fissures of certain rocks. They are sometimes, and especially in the caverns of England, accompanied with bones of elephants, rhinoceroses, and hippopotami, and with those of a hyena, which also occurs in several strata of transported matter, along with these same pachydermata. They are consequently of the same age; but it remains not the less difficult to say in what respect they differ from the oxen and deer of the present day.

The fissures of the rocks of Gibraltar, Cette, Nice, Uliveta near Pisa, and other places on the

---

* See my "Researches," vol. iv. p. 70.

shores of the Mediterranean, are filled with a red and hard cement, which envelopes fragments of rock and fresh-water shells, and numerous bones of quadrupeds, the greater part fractured. These concretions are termed osseous brecciæ. The bones which they contain sometimes present characters sufficient to prove that they have belonged to unknown animals, or at least to animals foreign to Europe. There are found, for example, four species of deer, three of which have characters in their teeth, which are only observed in the deer of the Indian Archipelago.

There is a fifth near Verona, the horns of which exceed in magnitude those of the Canadian deer *.

There also occur, in certain places, along with bones of rhinoceroses, and other quadrupeds of this period, those of a deer so much resembling the reindeer, that it would be difficult to assign distinctive characters to it ; a circumstance which is so much the more extraordinary, that the reindeer is at the present day confined to the coldest regions of the north, while the whole genus of rhinoceroses belongs to the torrid zone. †

There exist in the strata of which we speak,

---

* "Researches," vol. iv. p. 168–225.

† Id. p. 89.

remains of a species very similar to the fallow-deer, but a third larger,* and prodigious quantities of horns, very much resembling those of our present stag†, as well as bones, very like those of the aurochs ‡ and domestic ox ||, two very distinct species, which had been erroneously confounded by the naturalists who preceded us. The entire heads, however, resembling those of these two animals, as well as that of the musk-ox of Canada §, which have often been extracted from the earth, do not come from localities sufficiently well determined to enable us to assert that these species had been contemporaries of the great pachydermata, of which we have made mention above.

The osseous brecciæ of the shores of the Mediterranean have also afforded two species of *Lagomys*,¶ animals, the genus of which exists at the present day only in Siberia; two species of rabbits **, lemmings, and rats of the size of the

---

* See my "Researches," vol. iv. p. 94.

† Id. vol. iv. p. 98.

‡ Id. vol. iv. p. 148; and vol. v. part ii. p. 509.

|| Id. vol. iv. p. 150; vol. v. part ii. p. 510.

§ Id. vol. iv. p. 153.

¶ Id. vol. iv. p. 199–204.

** Id. vol. iv. p. 174, 177, 196; vol. v. part i. p. 55.

water-rat and domestic mouse [*]. In the caves of England two species are also found [†].

The osseous brecciæ even contain bones of shrew-mice and lizards [‡].

In certain sandy strata of Tuscany, there are teeth of a porcupine [||], and in those of Russia heads of a species of beaver, larger than ours, which M. Fischer has named *Trogontherium* [§].

But it is more particularly in the class Edentata that these races of animals belonging to the period before the last assume a size much superior to that of their present congeners, and even rise to a magnitude altogether gigantic.

The *Megatherium* unites a part of the generic characters of the armadilloes, with some of those of the sloths, and is in size equal to the largest rhinoceros. Its claws must have been of a monstrous length, and prodigious strength; its whole skeleton possesses an excessive solidity. It has only as yet been found in the sandy strata of North America [¶].

---

[*] See my "Researches," vol. iv. p. 178, 202, and 206; vol. v. part i. p. 54.

[†] Id. vol. v. part i. p. 55.

[‡] Id. vol. iv. p. 206.

[||] Id. vol. v. part ii. 517.

[§] Id. part i. p. 59.

[¶] Id. p. 174; and part ii. p. 519.

The *Megalonyx* has been very similar to it in its characters, but has been somewhat less; its claws much longer and sharper in the edges. Some bones and entire toes of it have been found in certain caves in Virginia, and in an island on the coast of Georgia [*].

These two enormous edentata have only hitherto presented their remains in America; but Europe possesses one of the same class which does not yield to them in magnitude. It is only known by a single terminal joint of a toe, but this fragment is sufficient to assure us that it was very similar to a pangolin or manis, but to a pangolin of nearly twenty-four feet in length. It lived in the same districts as the elephants, rhinoceroses, and gigantic tapirs; for its bones have been found along with theirs in a sandy deposit in the county of Darmstadt, not far from the Rhine [†].

The osseous brecciæ also contain, but very rarely, bones of carnivora [‡], which are much more numerous in caverns, that is to say, in cavities wider and more complicated than the fissures or veins containing osseous brecciæ. The Jura chain in particular, is celebrated for them in the part of it which extends into Germany, where, for ages past, incredible quantities have been removed and destroyed, on account of certain medical virtues which had been attributed to them, and yet there still remains enough to fill the mind with astonishment. The principal part of these remains consists of bones of a very large species of bear *(Ursus spelæus)*, which is characterised by a more prominent forehead than that of any of our living bears[*]. Along with these bones are found those of two other species of bear *(U. arctoideus* and *U. priscus)*[†]; those of a hyena *(H. fossilis)*, allied to the spotted hyena of the Cape, but differing from it in the form of its teeth and head[‡]; those of two tigers or panthers[§], of a wolf[‖], a fox[¶], a glutton[**], as well as of weasels, viverræ, and other small carnivora[††].

---

[*] See my "Researches," vol. v. part i. p. 160.

[†] Id. vol. v. p. 193.

[‡] Id. vol. iv. p. 193.

Here, also, may be observed that singular association of animals, the species resembling which live at the present day in climates so widely separated from each other as the Cape, the country of the spotted hyena, and Lapland, the country of our present gluttons. In like manner we have seen in a cave in France, a rhinoceros and a reindeer by the side of each other.

---

[*] See my "Researches," vol. iv. p. 351.

[†] Id. vol. iv. p. 356 and 357. [‡] Id. vol. iv. p. 392. and 507.

[§] Id. vol. iv. p. 452. [‖] Id. vol. iv. 458. [¶] Id. vol. iv. p. 461.

[**] Id. vol. iv. p. 475. [††] Id. vol. iv. p. 467.

Bears are of rare occurrence in alluvial strata. Remains of the large species of the caves (*U. spelæus*), are said, however, to have been found in Austria and Hainaut; and in Tuscany there are bones of a particular species, remarkable for its compressed canine teeth (*U. cultridens*) *. The hyenas are more frequently met with. We have remains of them in France, found along with bones of elephants and rhinoceroses. A cave has lately been discovered in England, which contained prodigious quantities of them, where they were found of every age, and of which the soil presented even their excrements in a sufficient state of preservation to be easily recognised. It would appear that they had long lived there, and that it had been by them that the bones of elephants, rhinoceroses, hippopotami, horses, oxen, deer, and various animals of the class of glires, which are found along with them, and which bear evident marks of their teeth, had been dragged into the cave. But what must have been the soil of England, when these enormous animals lived upon it, and constituted the prey of ferocious beasts! These caves contain also bones of

---

[*] See my "Researches," vol. iv. p. 378 and 507; and vol. v. part ii. p. 516.

tigers, wolves and foxes; but the remains of bears are of excessively rare occurrence in them *.

However this may be, we see that, at the epoch of the animal population which we are now passing under review, the class of carnivora was numerous and powerful. It reckoned three bears with round canine teeth, one with compressed canini, a large tiger or lion, another feline animal, of the size of the panther, a hyena, a wolf, a fox, a glutton, a martin or pole-cat, and a weasel.

The class of glires, composed in general of weak and small species, has been little observed by the collectors of fossil remains; and, in all cases, where the bones of these animals have been found in the strata or deposits of which we speak, they also have presented unknown species. Such, in particular, is a species of Lagomys found in the osseous brecciæ of Corsica and Sardinia, somewhat resembling the Lagomys alpinus of the high mountains of Siberia: so true is it that it is not always in the torrid zone only, that we are to seek for the animals which resemble those of this period.

These are the principal animals, the remains of which have been found in that mass of earth, sand, and mud,—that *Diluvium*, which everywhere covers our large plains, fills our caverns, and chokes up the fissures in many of our rocks. They incontestibly formed the population of the continents, at the epoch of the great catastrophe which has destroyed their races, and which has prepared the soil, on which the animals of the present day subsist.

---

* See Mr Buckland's excellent work, entitled *Reliquiæ Diluvianæ*.

Whatever resemblance certain of these species bear to those of our days, it cannot be disputed that the general mass of this population had a very different character, and that the greater part of the races which composed it have been utterly destroyed.

What astonishes us is, that, among all these mammifera, the greater number of which have their congeners at the present day in the warm parts of the globe, there has not been a single quadrumanous animal,—that there has not been collected a single bone or a single tooth of an ape or monkey, not so much even as a bone or a tooth belonging to an extinct species of these animals.

Nor is there any trace of man. All the bones of our species that have been found along with those of which we have been speaking, have occurred accidentally *, and their number besides is

---

* See in the *Reliquiæ Diluvianæ* of Mr Buckland the account of the skeleton of a woman found in the cave of Pa-

exceedingly small, which assuredly would not have been the case, if men had then been settled in the countries which these animals inhabited.

Where, then, was the human race at this period? Did the last and most perfect of the works of the Creator nowhere exist? Did the animals which now accompany him upon the globe, and of which there are no traces among these fossil remains, surround him? Were the countries in which he lived with them swallowed up, when those which he now inhabits, and whose former population may have been destroyed by a great inundation, were laid dry again? These are questions which the study of fossil remains does not enable us to solve, and in this discourse we must not apply for information to other sources.

This much is certain, that we are now at least in the midst of a fourth succession of land animals,—that, after the age of reptiles, the age of palæotheria, the age of mammoths, and that of mastodons and megatheria, has come the age in

---

vyland; and in my Researches, vol. iv. p. 193, that of a fragment of a jaw, found in the osseous brecciæ of Nice.

M. de Schlotheim collected human bones in fissures at Kœstritz, where there are also bones of rhinoceroses; but he himself expresses his doubts regarding the epoch at which they were deposited.

which the human species, aided by some domestic animals, peaceably governs and fertilizes the earth, and that it is only in the deposits formed since the commencement of this age, in alluvial matters, peat-bogs, and recent concretions, that bones are found in the fossil state, which belong all of them to known and still living animals.

Such are the human skeletons of Guadaloupe, imbedded in a species of travertine formed of land shells, slate, and fragments of shells and madrepores of the neighbouring sea; the bones of oxen, deer, roes, and beavers, common in peat-bogs, and all the bones of men and domestic animals found in the mud and sand deposited by rivers, in burying grounds, and upon ancient fields of battle.

None of these remains belong either to the great deposit formed at the time of the last catastrophe, nor to those of preceding ages.

APPENDIX.

APPENDIX.

On the birds to which the name of Ibis was given by the ancient Egyptians.

Every body has heard of the Ibis, a bird to which the ancient Egyptians rendered a religious homage; which they reared within the precincts of their temples; allowed to wander unmolested through their towns; whose murderer, even although he had involuntarily become so, was punished with death[*]; which they embalmed with as much care as their parents;—a bird to which they attributed a virgin purity; an inviolable attachment to their country, of which it was the emblem, an attachment so great that it suffered itself to die of hunger when it was transported elsewhere;—a bird which possessed instinct enough to know the increase and waning of the moon, and to regulate accordingly the quantity of its daily food, and the development of its young; which arrested at the frontiers of Egypt the serpents which would otherwise have carried destruction into that sacred land *, and which inspired them with such terror that they dreaded its very feathers †;—a bird, in fine, whose form the gods would have assumed, had they been forced to adopt a mortal figure, and into which Mercury was really transformed, when he had a mind to traverse the earth, and instruct men in the sciences and arts.

---

[*] Herodotus, i. 2.

No other animal could have been so easy to recognize as this; for there is no other of which the ancients have left us at once, as of the ibis, excellent descriptions, accurate and even *coloured* figures, and the body itself preserved with its feathers, under the triple envelope of a preservative bitumen, thick and close folds of linen, and solid and well varnished vases. And yet, of all the modern authors who have spoken of the ibis, there is but one, the celebrated Bruce, a traveller more famous for his courage than for the justness of his opinions in natural history, who has not blundered respecting the true species of this bird; and his ideas with regard to this subject, however accurate they were, have not even been adopted by naturalists [*].

---

* Ælian, lib. ii. cap. 35 and 38.

† Id. lib. i. cap. 38.

After several changes of opinion respecting the ibis, it was seemingly agreed, at the period when I published the first edition of this work, to give the name of Ibis to a bird a native of Africa, almost of the size of the stork, with white plumage, having the quills black, perched upon long red legs, armed with a long arched beak, of a pale yellow colour, sharp at its edges, rounded at its base, and notched at its point, and whose face is covered with a red skin destitute of feathers, which do not extend farther forward than the eyes.

Such is the Ibis of Perrault [†], the Ibis candida of Brisson [‡], the Ibis blanc d'Egypte of Bufffon *, and the Tantalus Ibis of Linnæus, in his twelfth edition. It was to this same bird, also, that Blumenbach, while he avowed that it is of very rare occurrence at the present day, at least in Lower Egypt, asserted that the Egyptians rendered divine honours †; and yet this naturalist had possessed opportunities of examining bones of the true ibis in a mummy which he opened in London ‡.

---

[*] Bruce, French translation, 8vo. vol. viii. p. 264; and Atlas, pl. xxxv., under the name of Abouhannès.

[†] Description d'un Ibis blanc et de deux cicognes, Academie des Sciences de Paris, t. iii. pl. iii. p. 61. of the 4to edition of 1734, pl. xiii. fig. 1. The beak is represented as truncated at the end, but this is a fault of the engraver.

[‡] Numenius sordide albo-rufescens, capite anteriore nudo rubro, lateribus rubro purpureo et carneo colore maculatis, remigibus majoribus nigris, rectricibus sordide albo rufescentibus, rostro in exortu dilute luteo, in extremitate au-

I also participated in the error of those celebrated men whom I have just mentioned, until the moment when I was enabled to examine some mummies of the ibis by myself. This pleasure was procured for me, for the first time, by the late M. Fourcroy, to whom M. Grobert, Colonel of Artillery, on his return from Egypt, had given two of these mummies, both taken from the pits of Saccara. On carefully exposing them, we perceived that the bones of the embalmed bird were

---

rantio, pedibus griseis. Ibis candida, Brisson, Ornithologia, t. v. p. 349.

* Planches Enluminées, No. 389; Histoire des Oiseaux, t. viii. 4to. p. 14. pl. 1. This last figure is a copy of that of Perault, with the same fault.

† Handbuch der Naturgeschichte, p. 203. of the edition of 1799; but in the edition of 1807 he has restored the name of Ibis to the bird to which it belongs.

‡ Philosophical Transactions for 1794.

much smaller than those of the *Tantalus ibis* of naturalists; that they did not much exceed those of the curlew in size, that its beak resembled that of the latter, being only a little shorter in proportion to its thickness, and not at all that of the tantalus; and, lastly, that its plumage was white with the quills marked with black, as the ancients have described it.

We are therefore convinced, that the bird which the ancient Egyptians embalmed, was by no means the Tantalus ibis of naturalists, that it was smaller, and that it was to be sought for in the curlew genus. We found, after some inquiries, that the mummies of the ibis which had been opened before by different naturalists, were similar to ours. Buffon says expressly that he examined several of them; that the birds which they contained had the beak and size of curlews; and yet he has blindly followed Perrault in taking the African tantalus for the ibis. One of those mummies opened by Buffon still exists in the museum; it is similar to those which we have examined.

Dr Shaw, in the supplement to his Travels *, describes and figures with care the bones of a similar mummy. The beak, he says, was six Engmost of the species of the family of scolopaceous birds.

---

* Folio edition, Oxford 1746, pl. v. and pages 64-66.

Lastly, our naturalists returned from the expedition to Egypt with a rich harvest of objects, as well ancient as recent. My learned friend M. Geoffroy St Hilaire, in particular, had occupied himself with the greatest care in collecting mummies of all descriptions, and had brought with him a great number of those of the ibis, both from Saccara and Thebes.

The former were in the same state as those which M. Grobert had brought, that is to say, their bones had undergone a sort of half burning, and were without consistence; they broke on the slightest touch, and it was very difficult to obtain any entire, and still more so to detach them for the purpose of making a skeleton.

The bones of those brought from Thebes were much better preserved, either on account of the greater heat of the climate, or from the more efficacious means employed for their preparation; and M. Geoffroy ha[illegible] sacrificed some of them to me, M. Rousse[illegible] assistant, succeeded, by dint of patience [illegible]ress, and by the employment of ingeni[illegible]elicate methods of procedure, in mak[illegible] entire skeleton, by stripping all the[illegible]nd connecting them with a very fine w[illegible] skeleton is deposited [illegible] anatomic[illegible] of the museu[illegible] forms one of the most beautiful ornaments, and we have represented it in Pl. IV.

It is likely that this mummy must have been that of a bird kept in a state of domesticity in the temples, for its left humerus has been broken and joined again. It is probable that a wild bird, whose wing had been broken, would have perished before it had healed, from its being unable to pursue its prey, or to escape from its enemies.

This skeleton puts it in our power to determine, without any uncertainty, the characters and proportions of the bird. We see clearly that it was in all points a true curlew, a little larger than the common curlew of Europe, but having the beak thicker and shorter. The following is a comparative table of the dimensions of the two birds, taken, for the ibis, from the skeleton of the mummy of Thebes, and for the curlew, from a skeleton which previously existed in our anatomical galleries. We have added those of parts of the Saccara ibises, which we succeeded in obtaining entire.

Parts.	Skeleton of an Ibis from Thebes.	Skeleton of the Curlew.	Saccara Ibises.	
			Larger.	Smaller.
Head and beak together,	0.210	0.215	...	...
Head alone, - - - -	0.047	0.040	...	...
The 14 vertebræ of the neck together, - -	0.192	0.150	...	...
Back, - - - - -	0.080	0.056	..	...
Sacrum, - - - - -	0.087	0.070	...	...
Coccyx, - - - - -	0.037	0.035	...	...
Femur, - - - - -	0.078	0.060	...	...
Tibia, - - - - -	0.150	0.112	...	0.095
Tarsus, - - - - -	0.102	0.090	...	...
Middle-toe, - - - -	0.097	0.070	...	...
Sternum, - - - -	0.092	0.099	...	...
Clavicle, - - - - -	0.055	0.041	...	0.04
Humerus, - - - -	0.133	0.106	0.124	...
Fore-arm, - - - -	0.153	0.117	0.144	0.114
Hand, - - - - -	0.125	0.103	...	...

It appears by this table, that the animal of Thebes was larger than our curlew; that one of the Saccara ibises was intermediate in size between that of Thebes and our common curlew, and that the other was smaller than this latter bird. It is also seen that the different parts of the body of the ibis do not observe the same proportions between each other, as those of the curlew. The beak of the former, for example, is in particular shorter, although all the other parts are longer, &c.

However, these differences of proportions do not exceed what might be expected in species of the same genus: the forms and characters which may be considered as generic, are absolutely the same.

We must therefore search for the true ibis, not among those tantaluses of large size and sharp beak, but among the curlews; and, let it be observed, that, by the name *curlew*, we intend to signify, not the artificial genus formed by Latham and Gmelin, of all the wading birds which have the beak curved downwards, but a natural genus, to which we shall give the name of *Numenius*, and which will comprehend all the waders with beaks curved downwards, soft and rounded, whether their head be bare or clothed with feathers. It is the genus *courlis*, such as Buffon imagined it *.

A glance over the collection of birds belonging to the royal cabinet, has enabled us to distinguish a species, which is neither named nor described in the works of systematic writers, excepting perhaps by Dr Latham; and which, when carefully examined, will be found to correspond with all that the ancients, the monuments and mummies, indicate as characteristic of the ibis.

We here present a figure of it, Plate v. It is a bird somewhat larger than the curlew; its beak is arcuate like that of the curlew, but a little shorter, and sensibly thicker in proportion, somewhat compressed at its base, and marked on each side with a groove, which, proceeding from the nostril, is continued to the extremity; while, in the curlew, there is a similar groove, which disappears before arriving at the middle of the beak; the colour of the beak is more or less black; the head, and the two upper thirds of the neck, are entirely destitute of feathers, and the skin of these parts is black. The plumage of the body, wings, and tail, is white, with the exception of the ends of the large quills of the wing, which are black; the four last secondary quills have the barbs singularly long, attenuated, and hanging down over the ends of the wings, when the latter are folded; their colour is a beautiful black, with violet reflections. The feet are black, the legs are thicker, and the toes much longer in proportion than those of the curlew; the membranes between the bases of the toes are also more extended; the leg is entirely covered with small polygonal, or what is called reticulated scales, and the base of the toes itself has only similar scales; while, in the curlew, two-thirds of the leg, and the whole length of the toes, are scutulate, that is to say, furnished with transverse scales. There is a reddish tint under the wing, toward the top of the thigh, and on the anterior large wing coverts; but this tint appears to be an individual character, or the result of an accident, for it does not occur in other individuals that are in other respects entirely similar.

---

* We have definitively established this genus in our "Regne Animal," t. i. p. 483, and it appears to have been adopted by naturalists.

This first individual came from the collection of the Stadtholder, and its native country was unknown. The late M. Desmoulins, assistant naturalist to the Museum, who had seen two others, asserted that they came from Senegal; one of them must even have been brought by M. Geoffroy de Villeneuve: but we shall see, as we proceed, that Bruce[*] found this species in Abyssinia, where it was named *Abou-Hannes* (Father John); and that M. Savigny saw it in abundance in Lower Egypt, where it was called *Abou-Mengel* (Father of the Sickle). It is probable that the moderns will give no credit to the assertion of the ancients, that the ibis never left Egypt without perishing[†]. This assertion would, besides, be as contrary to the Tantalus Ibis as to our common Curlew; for the individuals which we have in Europe came from Senegal. It was from thence that M. Geoffroy de Villeneuve had brought the individual in the Museum of Natural History. It is even much rarer in Egypt than our curlew; for, since Perrault, nobody mentions having seen it there, or having received it from that country. An individual without the reddish tint, but in other respects perfectly similar to the first, was brought home by M. de Labillardiere, in his voyage to Australasia made along with M. d'Entrecasteux.

---

[*] Bruce, *loc. cit.*; and Savigny, " Mem. sur l'Ibis," p. 12.

[†] Ælian, lib. ii. cap. 38

We afterwards learned, that, when young, these birds have the head and neck furnished with feathers in the part which, as they advance in age, is to become bare; and that the scapulars are less elongated, and of a paler and duller black. It is in this state that one was brought to us from Australasia by the late Peron, which, in other respects, differs from ours, and from that of M. Labillardiere, only in having some black markings on the alula and first large coverts, and in which the head and upper part of the neck are covered with blackish feathers. It was also a youngish individual which M. Savigny brought from Egypt, and which is figured in his memoir upon the Ibis, Plate I.; and in the great work on Egypt, under the head Birds, Pl. VII. The feathers of the head and back part of the neck are rather grey than black; those of the fore part of the neck are white. Lastly, Bruce's figure (Atlas, Plate XXXV.) is also taken from a young individual observed in Abyssinia, and almost similar to that of M. Savigny.

We have received from Pondicherry, by M. Leschenault, an individual similar to that of Peron, but in which, the head only, and a small part of the back of the neck, are furnished with blackish feathers: all the rest is covered with white feathers. But it is not the less certain, that all these birds have the head and the neck bare when they are full grown.

The late M. Macé sent from Bengal to the Museum several individuals of a species very nearly allied to this, which has the beak a little longer, and less arched, of which the first quill only has a little black on the two edges of its point, and of which the secondary quills are also somewhat attenuated, and slightly tinged with reddish.

It appears, according to M. Savigny, p. 25, that M. Levaillant observed another still, which has the secondary quills similarly elongated, but of which the neck always retains its feathers, and whose face is of a red colour.

The same M. Macé also sent us a tantalus, very much resembling that which has been regarded by naturalists as the ibis, but of which the small wing-coverts, and a broad band at the lower part of the breast, are black, and speckled with white. The last secondary quills are elongated, and tinged with rose-colour. It is known that, in the Tantalus ibis of naturalists, the small wing-coverts are speckled with purplish red, and that the whole under part of the body is white.

We give here a table of the parts of some of these birds, which could be accurately measured in stuffed individuals. By comparing them with those of the skeletons of embalmed ibises, one may judge if it were possible to believe for a single moment that these mummies belonged to the tantalus.

PARTS OF THE BODY.	Tantalus Ibis. of Naturalists	Macé's Indian Tantalus.	Numenius Ibis the true Ibis of the Ancients.	Numenius Ibis, measured by M. Savigny.	Macé's Numenius.	Labillardiere's Numenius.	Peron's Numenius.	Leschenault's Numenius.
Length of the beak, from its commissure to the tip, - - - - -	0.210	0.265	0.125	0.154	0.148	0.165	0.131	0.132
Length of the naked part of the leg, - - - -	0.130	0.150	0.041	0.056	0.055	0.040	0.034	0.044
Length of the tarsus, - - -	0.190	0.250	0.085	0.097	0.095	0.084	0.080	0.093
Length of the middle toe,	0.105	0.115	0.080	0.092	0.083	0.086	0.078	0.086

Let us now examine the books of the ancients and their monuments; let us compare what they have said of the ibis, or the figures of it which they have traced, with the bird which we have been describing; and we shall see all our difficulties vanishing, and all the testimonies according with what is best of all for the purpose, the body itself of the bird preserved in the mummy.

"The most common ibises," says Herodotus, (Euterpe, No. 76.) "have the head and the forepart of the neck bare, the plumage white, excepting on the head, the nape, the ends of the wings and of the rump, which are black.* Their beak and feet are similar to those of the other ibises."

How does it happen that the travellers of our times do not make so good descriptions of the birds which they observe as that which Herodotus has made of the ibis? How could this description have been applied to a bird which has only the face bare, and which has that part of a red colour, to a bird which has the rump white, and not covered over at least as ours by the black feathers of the wings?

---

[*] Ψιλὴ τὴν κεφαλὴν, καὶ τὴν δειρὴν πᾶσαν. Λευκὴ πτεροῖσι, πλὴν κεφαλῆς, καὶ αυχένος καὶ ἄκρων τῶν πτερύγων, καὶ πυγαίου ἄκρου. Larcher, in his French translation of Herodotus, has properly understood the difference of the words ἀυχην, the nape, and δείρη or δέρη the throat.

And yet this latter character was essential to the ibis. Plutarch (De Iside et Osiride) says, that the manner in which the white was cut by the black in the plumage of this bird, presented the form of a lunar crescent. It is, in fact, by the union of the black of the last quills, with that of the two ends of the wings, that there is formed, in the white, a large semicircular notch, which gives to the white the figure of a crescent.

It is more difficult to explain what he has intended to say, in averring that the feet of the ibis form an equilateral triangle with its beak. But we can understand the assertion of Ælian, that when it draws in its head and neck among its feathers, it represents, in some measure, the figure of a heart. * It was on account of this, according to Horus Apollo (c. 35.), the emblem of the human heart.

From what Herodotus says of the nakedness of the throat, and of the feathers which covered the upper part of the neck, he appears to have had under his eyes a middle aged individual; but it is not the less certain, that the Egyptians also knew very well the individuals with the neck entirely bare. We see such represented from sculptures in bronze, in Caylus's Collection of Egyptian Antiquities (vol. i. pl. x. no. 4., and vol. v.

---

* Ælian, lib. v. cap. 29.

. xi. no. 1.) This last figure is even so like ır bird represented in pl. v., that it might be id that it was taken from it.

The paintings of Herculaneum no longer leave y doubt on the subject. Plates 138 and 140 David's edition, and vol. ii. p. 315, pl. 59, and 321, pl. 60 of the original edition, which re- esent Egyptian ceremonies, shew several ibises ılking in the court of the temples. The cha- cteristic blackness of the head and neck are in ırticular recognised, and it is easily seen from e proportion which their figure bears to the ersons in the painting, that it must have been a rd of half a metre at the most, and not of a etre, or thereabouts, like the Tantalus ibis.

The mosaic of Palestine, also presents in its iddle part several ibises perched upon buildings. hey differ in nothing from those of the paint- gs of Herculaneum. A Sardonyx of Dr Iead's Collection, copied by Shaw, App. pl. v., ıd representing an ibis, seems to be a miniature the bird which we have described. A medal Adrian, in large bronze, represented in the 'arnesian Museum, vol. vi. pl. xxviii. fig. 16, ıd another of the same emperor, in silver, repre- ented in vol. iii. pl. vi. fig. 9, afford figures of ıe ibis, which, notwithstanding their smallness, e pretty like our bird.

With regard to the figures of the ibis, sculptured upon the plinth of the statue of the Nile at Belvedere, and upon the copy of it at the garden of the Tuileries, they are not sufficiently finished to serve as proofs; but among the hieroglyphics of which the Institute of Egypt has caused impressions to be made upon the spot, there are several which distinctly represent our bird. In plate iii. fig. 1, we give one of these impressions which M. Geoffroy has had the politeness to communicate to us.

We insist particularly on this latter figure, because it is the most authentic of all, having been made at the time, and on the spot where the ibis was worshipped, and being cotemporary with its mummies; while those which we have cited above, having been made in Italy, and by artists who did not profess the Egyptian worship, might have been less faithful.

We owe to Bruce the justice of saying, that he recognised the bird which he describes under the name of *Abou-Hannes,* as the true ibis. He says expressly, that this bird appeared to him to resemble that which the mummy pitchers contained; and further, that this Abou-Hannes, or *Father John,* is very common on the banks of the Nile, while he never saw there the bird represented by Buffon, under the name of the White Ibis of Egypt.

M. Savigny, one of the naturalists of the expedition to Egypt, equally asserts his not having seen the *Tantalus* in that country, but he obtained a great number of our *Numenius* near the Lake Menzale, in Lower Egypt, and carried their skins with him.

The Abou-Hannes has been placed by Latham, in his *Index Ornithologicus*, under the name of *Tantalus Æthiopicus*; but he does not speak of Bruce's conjecture respecting its identity with the ibis. The travellers before and after Bruce appear to have all been in error. Belon thought that the white ibis was the stork, in which he evidently contradicted all testimony on that head. No person has adopted his opinion in this matter, excepting the apothecaries, who have taken the stork for an emblem, because they have confounded it with the ibis, to which the invention of clysters is attributed *.

Prosper Alpinus, who relates that this invention is due to the ibis, gives no description of this bird in his Medicine of the Egyptians†. In his Natural History of Egypt, he speaks of it only after Herodotus, to whose account he only adds, without doubt from a passage of Strabo, which I shall mention farther on, that that bird resembles the stork in size and figure. He mentions his having been informed that white and black ones occurred in abundance on the edges of the Nile; but it is evident from his very expressions, that he did not believe it had been seen there *.

---

* Ælian, lib. ii. cap. xxxv;—Plut. De Solert. An.; Cic. de Nat. Deor. lib. ii.;—Phil. de Anim. prop. 16. &c.

† De Med. Ægypt. lib. i. fol. i. vers. Paris Edition, 1646.

Shaw says of the ibis,† that it is at the present day excessively rare, and that he has never seen it. His *Emsccsy*, or ox-bird, which Gmelin very improperly refers to the Tantalus Ibis, is of the size of the curlew, with the body white, and the beak and feet red. It frequents the meadows, where it follows the cattle; its flesh is not well tasted, and corrupts quickly. It is easy to see that this is not the Tantalus, and still less the Ibis of the ancients.

Hasselquist was not acquainted with the white Ibis nor with the black one; his *Ardea Ibis* is a small heron, which has the beak straight. Linnæus had acted very properly in placing it among the herons, in his tenth edition; but he erred, as I have said, in transporting it afterwards as a synonym to the genus *Tantalus*.

---

* Rer. Ægypt. lib. iv. cap. i. t. i. p. 199 of the Leyden Edition.

† See the French Translation, vol. ii. p. 167.

Demaillet * conjectures that the ibis might be the bird peculiar to Egypt, and which was named Pharaoh's Fowl *(Chapon de Pharaon)*, and at Aleppo *Saphan-bacha*. It devours serpents. There are of them white, and white and black; and it follows, for more than a hundred leagues, the caravans which go from Cairo to Mecca, for the purpose of feeding upon the carcases of animals which are killed during the journey, while at any other time there is not one seen along this route. But the author does not consider this conjecture as certain; he even says, that we must give up understanding the ancients, when they have spoken so as not to be understood. He ends with concluding, that the ancients have perhaps indiscriminately comprehended under the name of Ibis, all birds which rendered to Egypt the service of clearing it of the dangerous reptiles which this climate produces in abundance, such as the vulture, the falcon, the stork, the sparrow-hawk, &c.

He had reason not to regard his Pharaoh's fowl as the ibis; for, although its description is very imperfect, and although Buffon fancied he recognised the ibis in it, it is easy to judge, as well as by what Pokocke says of it, that this bird must be a carnivorous one; and, in fact, we see from Bruce's figure (Vol. v. p. 191. of the French edition), that Pharaoh's fowl is nothing else than the *rachama* or the small white vulture with black wings (*Vultur perenopterus*, Linn.)—a bird very different from what we have proved above to be the ibis.

---

* Description de l'Egypte, part ii. p. 23.

Pokocke says that it appears, from the descriptions which are given of the ibis, and from the figures which he has seen of it in the temples of Upper Egypt, that it was a species of Crane. I have seen, he adds, a number of these birds in the islands of the Nile; they were for the most part greyish [*]. These few words suffice to prove that he did not know the ibis better than the others.

The learned have not been more happy in their conjectures than the travellers. Middleton refers to the ibis, a bronze figure of a bird, of which the beak is arched, but short, the neck very long, and the head furnished with a small crest, a figure which never had any resemblance to the bird of the Egyptians [†]. This figure is, besides, not at all in the Egyptian style, and Middleton himself agrees that it must have been made at Rome. Saumaise upon Solinus says nothing that relates to the present question.

---

[*] Antiq. Monum. Pl. x. p. 129.

[†] Hist. Anim. lib. ix. cap. xxvii, and lib. x. cap. xxx.

As to the black ibis, which Aristotle places only near Pelusium [*]; it was long thought that Belon alone had seen it[†]. The bird which he describes under this name is a species of curlew, to which he attributes a head similar to that of the cormorant, that is to say, apparently bald, a red beak, and feet of the same colour; but as he does not speak of the ibis in his journey [‡], I suppose that it was only in France that he made this reference, and by comparison with mummies of the Ibis. What is certain is, that this curlew, with the beak and feet red, was not known in Egypt [§], but that our green curlew of Europe (*Scolopax Falcinellus*, Linn. Pl. Enl. 819.) is seen very commonly there, that it is even more abundant than the white numenius [||]; and, as it resembles it in form and size, and, further, as its plumage may appear black, it can by no means be doubted that it was the true black ibis of the ancients. M. Savigny also made a drawing of it in Egypt, but from a young individual only*. Buffon's figure is from an adult bird; but its colours are too pale.

---

[*] Buffon, Histoire Naturelle des Oiseaux, 4to, vol. viii. p. 17.

[†] Belon, Nature des Oiseaux, p. 159 and 200; and Portraits d'Oiseaux, folio 44, vers.

[‡] Observations de plusieurs singularités, &c.

[§] Savigny, Memoire sur l'Ibis, p. 37,

[||] Idem, ibid.

The error which prevails at present respecting the white ibis began with Perrault, who was also the first naturalist who made known the Tantalus ibis of the present day. This error, adopted by Brisson and Buffon, passed into the twelfth edition of Linnæus, where it is blended with that of Hasselquist, which had been inserted in the tenth, forming with it a compound altogether monstrous.

It was founded on the idea, that the ibis was essentially a bird that destroyed serpents, and upon this very natural conclusion, that, in order to enable it to devour these reptiles, it was necessary for it to have a sharp beak, more or less resembling that of the heron. This idea is even the only good objection that can be made against the identity of our bird to the ibis. How, it is urged, could a bird with a weak bill, a curlew, devour those dangerous reptiles?

It may be replied, that positive proofs, such descriptions, figures, and mummies, ought always to preponderate over accounts of habits too often imagined without any other motive than to justify the different worships rendered to animals. It might be added, the serpents from which the ibis delivered Egypt, are represented to us as very venomous, but not as very large. I have even obtained a direct proof that the birds preserved as mummies, which have had a beak precisely similar to that of our bird, were true serpent eaters; for I found in one of their mummies the still undigested remains of the skin and scales of serpents, which I have deposited in our anatomical galleries.

---

* See the Great Work on Egypt, Natural History of Birds, pl. vii. fig. 2.

But, at the present day, M. Savigny, who has observed, in a living state, and more than once dissected our white numenius, the bird which every thing concurs to prove to have been the ibis, asserts that it only eats worms, fresh water shells, and other small animals of that sort. Supposing this fact to have no exception, all that can be concluded from it is, that the Egyptians, as has happened more than once to them and others, had invented a false reason for an absurd worship. It is true that Herodotus says, he saw, in a place on the borders of the desert *, near

---

* Euterpe, cap. lxxv. Herodotus says a place in Arabia, but it is not seen how a place in Arabia could have been *near the city of Buto,* which was in the western part of the Delta.

Buto, a narrow gorge, in which a multitude of bones were heaped up, which he was informed were remains of winged serpents, that were seeking to penetrate into Egypt in spring, and that the ibises had arrested their passage. But he does not say that he had witnessed their combats, or that he had seen those winged serpents in their entire state. The whole of his testimony, therefore, reduces itself to this, that he had observed a heap of bones, which may very well have been those of the multitude of reptiles and other animals which the inundation destroyed every year, and whose bodies it would naturally carry to the places where it was stopped, to the borders of the desert, and which must by preference have accumulated in a narrow gorge.

However, it is equally from this idea of the combats of the ibis with serpents, that Cicero gives that bird a horny and strong beak [*]. Having never been in Egypt, he imagined that this must have been the case by mere analogy.

I am aware that Strabo says somewhere, that the ibis resembles the stork in form and size [†], and that this author ought to have known it well, since he asserts that in his time the streets and cross-ways of Alexandria were so filled with them, that they proved a great inconvenience; but he must have spoken of it from memory. His testimony cannot be received when he contradicts all the rest, and especially when the bird itself is there to refute him.

---

[*] Avis excelsa, cruribus rigidis, corneo proceroque rostro. Cic. de Nat. Deor. lib. i.

[†] Strabo, lib. xvii.

In like manner, I shall not trouble myself about the passage where Ælian [*] relates, according to the Egyptian embalmers, that the intestines of the ibis are eighty-six cubits long. The Egyptian priests of all classes have been guilty of so many extravagancies with regard to Natural History, that no great importance can be attributed to what one of their lowest classes might aver.

An objection might still be drawn against my opinion from the long attenuated and black feathers which cover the rump of our bird, and of which some traces also are seen in Bruce's figure of the Abou-Hannes. The ancients, it might be said, do not speak of them in their descriptions, and their figures do not exhibit them. But I have more on my side, in respect to this matter, than a written testimony or a figured representation. I have found precisely the same feathers in one of the Saccara mummies; I kept them carefully as being at once a singular monument of antiquity and a peremptory proof of the identity of species. These feathers having an uncommon form, and not occurring, I believe, in any other curlew, leave, in fact, no doubt respecting the accuracy of my opinion.

---

[*] Ælian, Anim. lib. x, cap, xxix.

I conclude this memoir with a view of its results:

1. The Tantalus Ibis of Linnæus ought to constitute a separate genus, along with the *Tantalus Loculator*. Their character would be: *Rostrum læve, validum, arcuatum, apice utrinque emarginatum.*

2. The other Tantali of the last editions should form a genus with the common curlews, to which the name of *Numenius* might be given. The character of the genus would be: *Rostrum teres, gracile, arcuatum, apice mutico.* For the special character of the subgenus of the Ibises, there should be added: *Sulco laterali per totam longitudinem exarato.*

3. The white ibis of the ancients is not the ibis of Perrault and Buffon, which is a *Tantalus;* nor the ibis of Hasselquist, which is an *Ardea;* nor the ibis of Maillet, which is a *Vulture;* but it is a bird of the genus Numenius, and of the sub-genus Ibis, which has hitherto been described and figured only by Bruce, under the name of *Abou-Hannes.* I give it the name of NUMENIUS IBIS, *albus, capite et collo adulti nudis, remigum api-*

cibus, rostro et pedibus nigris, remigibus secondariis elongatis nigro-violaceis.

4. The black ibis of the ancients is probably the bird which we know in Europe under the name of Green Curlew, or the *Scolopax Falcinellus* of Linnæus. It also belongs to the genus Numenius, and to the sub-genus Ibis.

5. The *Tantalus Ibis* of Linnæus, in the present state of synonymy, comprehends four species of three different genera, namely,

1. A Tantalus, the ibis of Perrault and Buffon;

2. An Ardea, the ibis of Hasselquist;

3. and 4. Two Numenii, the ibis of Belonius, and the ox-bird of Shaw.

From this example, and so many others, one may judge of the state in which the *Systema Naturæ* still exists, which it would be of so much advantage to purge by degrees of the errors with which it abounds, and which would seem to be every day increasing, by the addition of species, characters, and synonyms, made without selection and without critical examination.

The general conclusion of the whole investigation is, that the Ibis still exists in Egypt, as it did in the days of the Pharaohs, and, that it was owing to the inaccuracy of naturalists that the species was for some time thought to be extinct, or to have been altered in its forms.

GEOLOGICAL ILLUSTRATIONS,

BY

PROFESSOR JAMESON.

In Civil History records are consulted, medals examined, and antique inscriptions decyphered, in order to determine the epochs of human revolutions, and verify moral events; so in Natural History we must search the archives of the world; draw from the bowels of the earth the monuments of former times; collect the fragments, and gather into one body of proofs all the indices of physical changes, which may enable us to retrace the different ages of nature. It is thus only that we can fix some points in the immensity of space, and mark the progressive stages in the eternal march of time.

ILLUSTRATIONS.

Note A and B, p. 9.

On the Subsidence of Strata.

M. Cuvier adopts the opinion of De Luc, that all the older strata of which the crust of the earth is composed, were originally in an horizontal situation, and have been raised into their present highly-inclined position, by subsidences that have taken place over the whole surface of the earth.

It cannot be doubted, that subsidences, to a considerable extent, have taken place; yet we are not of opinion that these have been so general as maintained by these geologists. We are rather inclined to believe, that the present inclined position of strata is in general their original one;—an opinion which is countenanced by the known mode of connection of strata, the phenomena of veins, particularly contemporaneous veins, the crystalline nature of every species of older rock, and the great regularity in the *direction* of strata throughout the globe.

The transition and flœtz-rocks also are much more of a chemical or crystalline nature than has been generally imagined. Even sandstone, one of the most abundant of the flœtz-rocks, occasionally occurs in masses, many yards in extent, which individually have a tabular or stratified structure; but, when viewed on the great scale, appear to be great massive distinct concretions. These massive concretions, with their subordinate tabular structures, if not carefully investigated, are apt to bewilder the mineralogist, and to force him to have recourse to a general system of subsidence or elevation of the strata, in order to explain the phenomena they exhibit.

NOTE C, p. 13.

DELUGE.

There are many facts, some of which are recorded in the Bible, that are hostile to Cuvier and De Luc's opinions stated in the text, viz. that the bed of the ocean was changed at the flood, or last great catastrophe; and that the land, formerly occupied by animals, was henceforth given up to fishes and other marine tribes. We are told, for example, that the dove, which was sent forth from the ark, found an olive-tree, whence it plucked a leaf, to carry back to the patriarch, as a proof that the waters of the deluge were subsiding; and we also find that the Assyrian rivers, which originally marked the situation of Eden, retained the same geographical relations after the earth had been repeopled. The natural history of the fossil organic remains contained in alluvial deposits, is also in opposition to the opinion of De Luc.

Note D, p. 19.

FORMATION OF PRIMITIVE MOUNTAINS.

Mitscherlich, in a memoir read before the Royal Academy of Berlin, but not yet published, enters fully into the illustration of the igneous origin of mountains, especially those of the primitive class, deducible from his experiments on the formation of minerals by fusion. As the view is interesting, we shall here give a short sketch of it.

Have the primitive mountains of our globe, whose form necessarily supposes a fluid state, been dissolved in water; or has the temperature of our earth been raised to such a degree, that the substances of which our primitive mountains are formed have become fluid? This question has been differently answered, and the solutions given have been attempted to be supported in proportion as the observation of geological facts, and the inquiries instituted with reference to the chemical combinations which compose the earth, have been developed. New observations, and the discovery of unknown laws in chemistry and mineralogy, must, at the same time, open a new field for speculation and observation in geology. Of the discoveries of our own times, there certainly is none which has exercised a greater influence upon mineralogy than that of determinate proportions, and especially the result of the researches of Berzelius, that the chemical combinations which nature produces, are formed according to the laws which he has discovered with regard to artificial combinations; a result which has entirely changed the aspect of this science, and has elicited a new system of mineralogy, in which the natural-chemical combinations are ranked with those which are artificial; which affords a confirmation to the laws of crystallography, as being the same in both cases.

It has been objected to the truth of the position, that the laws of natural combinations are the same as those which artificial combinations follow; that chemistry can decompose minerals; but that, in the formation of these combinations, natural laws have been in activity, which art would in vain attempt to reproduce: but this objection is groundless. The chemical affinity which acts in artificial combinations is a power of nature, as well as the affinity which regulates the composition of natural combinations: chemical affinity, in general, is a quality of matter. In this objection, modifying circumstances have been confounded with laws. The chemist would very easily refute the objection, if he could compose minerals of their elements, and produce artificial combinations similar in all their characters to minerals themselves. From such researches, there would, at the same time, be diffused a new light upon geological investigations. In this manner many phenomena would be reproduced, which have taken place at the formation of the earth; geological observations would be repeated by experiments, which might be varied at pleasure, for confirming these observations; and the recurrence in nature itself would be sought of those phenomena which have been produced in the laboratory;—inquiries, which are, however, of great importance, because they may be arbitrarily disposed and arranged according to the theory in view.

The importance of such attempts shew the value of any experiments that go to prove the formation of minerals by artificial means; and Mitscherlich has been very successful in detecting several mineral species formed artificially.

Berzelius has shown, in his Chemical System of Mineralogy, that the greater part of the chemical combinations of which our Earth is composed, and especially the primitive mountains, are analogous to salts and double salts; and that, in these combinations, the silica, carbonic acid, and oxide of iron, act the part of acids; the silica combines with the alumina, lime, magnesia, protoxide and peroxide of iron, protoxide of manganese, potash and soda, forming, with these bases, either simple salts, or double salts, in proportions determined by the different degrees of saturation; the carbonic acid is combined with the lime and manganese, and the peroxide of iron with the protoxide.

The object which should be proposed in these attempts, of which we speak, is to investigate the relation of these bases to the three acids. We find ourselves fortunately seconded in this attempt by a branch of national industry; for the complete extraction of the greater number of metals depends upon the relation of the silica to the above-mentioned bases, the degrees of saturation in which the silica may occur with them, the greater or less degree of affinity with which these bases combine with the silica, and, lastly, the chemical qualities of the combination formed. It is necessary for the metallurgist that he endeavour, in order to attain his object completely, to produce, in proportion as the minerals differ, different chemical combinations of the substances which compose these minerals; but always in determinate proportions, either by adding a foreign substance, or by regulating the fusion by the choice of minerals. The combinations which the metallurgist thus produces, are ordinarily minerals which have already been found in nature, sometimes even new species.

During a journey in Sweden, Mitscherlich observed at Fahlun, where he made inquiries regarding the ores, the scoriæ, and in general regarding the extraction of copper, in order to form a correct idea of this operation, not only some well-formed crystals in the scoriæ; but also found that the whole mass of the slag had a crystalline texture; and that the crystals, and the joints of the slags which had a lamellar texture, remained the same at different periods of fusion, provided only that the manner of operating of the metallurgist remained the same. The examination of the crystalline figure of the slag proved, that it was that of a mineral which has a composition analogous to that of the slag. After having made this observation, he found in almost every foundery which he visited in Sweden, different crystalline combinations, which resembled minerals. Thus he found at Fahlun, silicate and bisilicate of protoxide of iron; at Garpenberg, mica, and several times augite and chrysolite. These combinations have not only the same crystalline figures, but also all the other characters of the corresponding minerals.

I have pursued these inquiries, says Mitscherlich, since my return from Sweden; I have analysed the productions which I have found, and the analysis has confirmed what the exterior had led to anticipate. I have also augmented my observations by journeys in various districts of Germany; and farther, I have been seconded in my researches by my friends; so that I now possess upwards of forty different species of crystallized chemical combinations produced by fusion, the greater number of which are minerals already known; some are new species, which have not hitherto been met with in nature.

The occurrence of mica, which forms a predominant constituent part of our primitive mountains, as an artificial production, gave rise to the following geological speculations.

The artificial production by fusion, of the minerals which compose our primitive rocks, appears, according to Mitscherlich, to place beyond doubt the theory that our primitive mountains were formerly a melted mass. Such a state of fluidity, he continues, affords an easy explanation of the figure of the Earth, of the increase of temperature as we proceed into its interior, of hot springs, and of many other phenomena. With respect to this theory, we may refer to M. Laplace, who is convinced of its plausibility, without grounding his belief upon the reasons which chemistry presents. I propose, however, to make mention of a few facts, in order to shew with what facility many chemical phenomena in geology may be explained by following this theory.

Primitive mountains are generally distributed over the surface of the earth: it necessarily follows that the bodies which have composed the surface of the earth have participated of the temperature which the primitive mountains have had at the period when they were in a fluid state. The temperature at which water boils depends upon the pressure of the atmosphere; and if the temperature of the earth increases, we only require to diminish the mean height of the sea 32 feet, in order to have a pressure of an atmosphere more; and it is by this pressure that the degree of temperature at which water boils will also be raised higher. M. Laplace judges from the height of the sea during flowing and ebbing, that the mean depth of the sea is about 96,000 feet. Supposing three-fourths of this mass of water were converted into vapour, the pressure of this vapour would be nearly equal to 2250 atmospheres; and this pressure would so augment the degree of heat at which water enters into ebullition, that the primitive mountains might be in a state of fusion, without the water with which they are covered being heated to the boiling point; for the water which is not converted into vapour, and whose quantity is a fourth of the whole mass of vapour, according to the supposition which we have made, would cover the whole earth, because water expands in increasing proportion if the temperature be raised, and because the expansion of water is much greater than that of the mass of our primitive mountains; and, consequently, according to this supposition, our primitive mountains are formed, covered with red hot water. The great pressure of so many atmospheres necessarily modifies the reciprocal affinities of the substances which compose the primitive mountains.

Primitive mountains are distinguished from volcanic productions in this, that the lime and magnesia, which in them are combined with carbonic acid, form with the silex silicates and bisilicates. It is necessary that the silex, which, under the ordinary pressure, and at an elevated temperature, expels the carbonic acid, exercise no influence under the pressure of so many atmospheres;

and it is not surprising that crystals of quartz occur in Carrara marble. In volcanic productions, this pressure no longer exists, and we should find among these the same phenomena which our laboratories and metallurgic operations present. Following this theory, the circumstances that primitive mountains contain gypsum and carbonates, and that water occurs in quartz, very readily admit of explanation. And with regard to this latter phenomenon, the observations detailed by Sir Humphry Davy afford an additional confirmation of the theory in question.

We may explain in the same manner another phenomenon, which is more in connection with the present state of our globe. Many observations shew that the sea stood formerly at a much higher level than it does at present. The water of the sea expands, if the temperature be elevated more than the land. Admitting that the surface of the earth has a temperature of 80° of Reaumur, and that the mean depth of the sea may be 96,000 feet, the height of the sea would then be 4000 feet higher than it is at present. If we suppose, as may be done without committing any great error, that the expansion of the primitive mountains is equal to that of glass, and that they have been at a temperature of 200°, and even at a much lower one, the water of the sea would cover the secondary mountains, in which we find the remains of marine animals. This explanation of the former height of the sea appears very simple, because the elevated temperature of the earth may have resulted either from its original state of fluidity, or from a geological revolution, which has destroyed, at the same time, the organic beings of a former period.

If primitive mountains and volcanic formations have been fluid, and have crystallised on cooling, it is necessary that we should retrace in them the same phenomena and the same laws which we still observe at the present time. If a fluid body become solid by cooling, these phenomena are differently modified, according to the chemical nature of the bodies, and according to the crystalline forms which they acquire on cooling; but the laws remain always the same. Mitscherlich says, I am in possession of some specimens which explain several of the phenomena so often shewn by basalt and volcanic formations. I do not possess artificial basalt resembling the natural columnar kind; yet the slags obtained at the furnaces of Sahla resemble basalt so perfectly, as to deceive the most experienced eye, especially as their cavities contain crystals of augite. But I have found at Fahlun a bisilicate of protoxide of iron, which has in consequence a composition analogous to that of basalt, and which has distinct joints. In this slag we perceive that the joints, which are parallel to the axis of the prism and to the lateral planes of the crystals, are always perpendicular to the plane of cooling. This is particularly observable in a specimen which was obtained by melting the slag in a mould; on crystallizing it had several planes of cooling, and the joints are parallel to each of these planes. The planes of separation in basalt present exactly the same phenomenon as this slag.

The phenomena which take place when a fluid body crystallizes may be observed in sulphur, better than in any other body. All fluid bodies, however, and even water, on freezing, present the same phenomena.

If a fluid body has cooled to the point at which it begins to become solid, for example, sulphur, in a round vessel, a crust of sulphur is not formed upon the surface of the cooled vessel, and another crust upon the surface of the sulphur itself, as might be expected; on the contrary, if a crystal be formed upon a point of the inner surface of the vessel, the crystal enlarges by growing in the direction of its axis, and the mass which surrounds the crystal remains liquid, and sometimes cools, without the molecules arranging themselves in the same manner as the crystal already formed. On examining the cooled mass, we observe that it shews a lamellar texture where the crystal was formed, and that the mass which surrounded it does not shew this texture in the same degree. This explains how veins of large-granular granite traverse a small-granular granite, as well as other phenomena of the same nature.

This observation also affords an explanation of another phenomenon. If the half of the liquid mass has become solid, and if the fluid part be poured off, we obtain isolated crystals, which have been formed in the fluid mass. If the fluid part be not poured off, and be permitted to cool slowly, it contracts, as is the case with most bodies, and the contraction produces the same effect as the decantation; small cavities will be formed, and these will be traversed and covered over with distinct crystals. We also observe this phenomenon in the geodes of primitive and volcanic mountains, in which the crystals they contain are of the same minerals as those of which the mountains themselves are composed.

NOTE E, p. 23.

ON THE DISTRIBUTION OF BOULDER STONES IN SCOTLAND, HOLLAND, GERMANY, SWITZERLAND, AND AMERICA.

Numerous large blocks are met with in almost every country of Europe, and frequently far removed from their original situations. This is frequently the case in Scotland: thus, in the Edinburgh district, we have numerous blocks of primitive rocks, of which no fixed rocks occur nearer than in our Highland mountains.

In the north of Holland, Germany, and the countries bordering on the Baltic, enormous fragments of granite and syenite are scattered within certain limits. According to Humboldt, it seems to be now proved, that they have been carried southward, with a distribution like that of radii from a centre, from the Scandinavian peninsula, during some of the ancient revolutions of our globe, and that they have not originally belonged *to the granitic* chains of the Hartz and Saxony, which they approach without, however, actually attaining their basis [*]. Born, says Humboldt, on the sandy plains of the Baltic, and until the age of eighteen, not knowing any other rock than these scattered blocks, I could not but feel curious to know whether the new world presented any thing of a similar nature. I was surprised not to find a single block of this description in the *Llanos* of Venezuela, although the immense plains were immediately bordered to the south by a group of mountains entirely granitic [*], and which presents, in its broken and almost columnar peaks, traces of the most violent action [†]. Towards the north, the granitic chain of the Silla of Caracas and of Portocabello is separated from the Llanos, by a range of mountains which are schistose between Villa de Cura and Parapara, and calcareous between the Bergantin and Caripe. I was equally struck with the same absence of blocks upon the banks of the Amazon. La Condamine had already affirmed, that from the Pongo of Manseriche to the strait of Pauxis, not the smallest stone was to be observed. Now, the basin of the Rio Nigro and of the Amazon is also but a Llano, a plain like those of Venezuela and Buenos Ayres, the difference consisting only in the state of the vegetation. The two Llanos, situated at the northern and southern extremities of South America, are covered with gramineæ; they are Savannas destitute of trees. The intermediate Llano, that of the Amazon, exposed to almost continual equatorial rains, is a thick forest. I do not remember to have heard that the Pampas of Buenos Ayres or the Savannas of the Missouri [‡] and New Mexico contain granitic blocks. The absence of this phenomenon appears general in the new world. It is probably equally so in the Sahara in Africa; for we must not confound rocky masses which pierce the soil in the midst of the desert, and of which mention has often been made by travellers, with mere scattered fragments. These facts seem to prove, that the blocks of Scandinavian granite, which cover the sandy plains on the southern side of the Baltic, in Westphalia, and in Holland, are owing to a particular debacle which proceeded from the north, to a purely local catastrophe. The old conglomerate (grès rouge), which covers a great part of the Llanos of Venezuela and of the basin of the Amazon, contains, without doubt, fragments of those same primitive rocks of which the neighbouring mountains are composed; but the convulsions of which these mountains present undoubted evidences, do not seem to have been accompanied with circumstances favourable to the transportation of great blocks. This geognostic phenomenon is so much the more unexpected, that nowhere in the world does there exist a plain so continuous, and which is prolonged with fewer interruptions to the abrupt declivity of a purely granitic cordillera. Before my departure from Europe, says Humboldt, I had already been struck with the observation that there are no primitive blocks in Lombardy, nor in the great plain of Bavaria, which is the bottom of an ancient lake, having an elevation of 250 fathoms above the level of the ocean. This plain is bounded on the north by the granites of the Upper Palatinate, and on the south by the alpine limestones, transition clay-slates, and mica-slates of the Tyrol.

---

[*] Leopold de Buch, Voyage en Norwege, t. i. p. 30. of the German edition.

---

[*] The *Sierra Parima.*

[†] T. ii. p. 233, 236, 252, 273, 288, 382, 597, 627, and 633.

[‡] Are there any blocks in North America to the north of the Great Lakes?

Boulders, or loose blocks of alpine rocks, are found in the lower part of the Alpine valleys, which terminate in the great principal valley that stretches between the Alps and the Jura, from the Lake of Geneva to the Lake Constance; and are also found almost every where in this great principal valley. They are sometimes met with 4000 feet above the level of the sea, on the side of the Jura, facing the Alps, and also in considerable numbers in many of the valleys of the Jura itself. These blocks occur only on the surface, never in any solid rock, and no one ever met with them in the subjacent strata of sandstone, marl, or conglomerate of the hills and valleys, interposed between the Alps and the Jura; but they are sometimes found deep in the soil, or imbedded or surrounded with the debris formed by rivers.

The traveller is often surprised by the enormous magnitude of these loose blocks, some of them being calculated to contain 50,000 cubic feet. The smaller masses are distinguished from those brought down by rivers, by their position, that is, their occurring on heights and acclivities, where no river could ever have run. They may also be confounded with blocks from decaying conglomerate; hence it is proper to be on our guard, not only to distinguish these blocks from those derived from conglomerate rocks, but also from the rolled masses belonging to river courses.

The height at which they are found does not appear to have any relation to their magnitude, for we often find very large blocks at considerable heights, and also in deep valleys; and we also meet with small masses as well in the bottoms of valleys, as high up on the mountains.

They occur sometimes in heaps, or dispersed in single blocks; but these relations have no connection with their magnitude, because we often find large and small masses in the same heap, and single, large, and small, blocks on mountain summits, and in the bottoms of valleys. The smaller blocks are more or less rounded, but seldom so much so as the boulders of rivers, which have been exposed to long continued friction. The larger blocks are indeed angular, but not sharp edged. But in examining this relation, we must carefully distinguish whether or not the angles or edges are original, or have been produced by subsequent, natural, or artificial causes. Very often masses of this description are blasted with gunpowder, either with the view of clearing the fields, or of obtaining stones for building; and these, if left on the ground, may lead into error.

These blocks vary in their nature, some being of the primitive class, while others belong to those of the transition and secondary classes. In general, they appertain to rock formations, situated nearer to the central alpine chains than those of the places where they are found. Thus, no rocks of the transition class occur in gneiss valleys; no alpine limestone in transition valleys; and, in general, nowhere but in Jura, do blocks of Jura limestone make their appearance. Therefore, all the loose blocks of rocks between the Jura and the Alps, belong to the strata of the high chains of the Alps.

But these blocks have different characters in different districts. The loose blocks which occur in the river basin of the Rhone, and the Lake of Geneva, are quite different from those which lie strewed about in the river basin of the Rhine. These, again, are equally different from the loose blocks of the river basin of the Aare, as those of the Aare are from the blocks of the Lake of

Zurich, and the valley of Limmat; and these in their turn are equally well distinguished from the great accumulations in the valley of the Reuss. It rarely happens that intermixtures take place among these different accumulations of debris, and this is a circumstance which must be attended to in our investigation.

It results from an accurate comparison of these loose blocks with those mountain rocks which occur in extensive chains in the high Alps; that the loose blocks of every known river basin agree with the rocks which form the sides of the upper parts of those high Alpine valleys, which are in immediate connection with these great water basins. Thus the loose blocks of the water basin of the Rhine are similar to the rocks of Bundten. We find in the Lake of Zurich, and in the Limmat valley, the rocks of the Glarner land in loose blocks. The debris in the basin of the Reuss consists of rocks of the mountains from which the Reuss takes its rise. The loose blocks of the water basin of the Aare are similar to the mountain rocks of the high Alps of Bern; and the loose blocks, found in the course of the Rhone, occur in fixed rocks in the Vallais.

It thus appears that the loose blocks are by no means irregularly dispersed over the great valley between the Alps and the Jura, but are distributed in the direction of distinct water basins. It also appears, that the loose blocks are not irregularly distributed in these different basins; on the contrary, that, in some parts of the basin, they are accumulated in great numbers; in other places they are rare, and in some situations none occur.

From the preceding observations, we may obtain some hints of importance in respect of the cause of this remarkable phenomenon. These loose blocks already occur in the alpine valleys, which open into the great valley, between the Alps and the Jura. They are found more abundantly in the wide parts of valleys immediately below the narrow or contracted passes, and few occur in the narrow, steep, and rocky parts of the valleys.

Loose blocks are found, at a greater or less height, in the smaller lateral valleys that open into the transverse alpine valleys, which terminate in the great valley between the Alps and the Jura. If these lateral valleys form passes (which lead over into other valleys by a lowering of the high mountain chain), which are not more than 4000 feet above the level of the sea, loose blocks occur, not only in these passes, but also more or less widely distributed in the opposite valleys. In the great principal valley which stretches between the Alps and the Jura, from the Lake of Geneva to beyond the Lake Constance, we find these loose blocks dispersed over all the hills whose elevation is not more than 3000 feet above the level of the sea; but even here the distribution of the blocks is not entirely irregular. The largest are found on such hills and acclivities as are opposite the mouths of the alpine valleys, in the great principal valley. The blocks are frequently found higher on such acclivities, than on the sides of those valleys which may be considered as a continuation of the alpine valleys. The loose blocks are found every where on that acclivity of the Jura range which is opposite to the Alps, and they are found highest and largest in those places which are directly opposite the mouths of the alpine valleys. In such places, the blocks again attain an elevation of nearly 4000 feet above the level of the sea; whereas, in the intermediate places, which are most remote from the places opposite the mouths of the alpine valleys, the blocks seldom reach at a height of 2000 feet above the level of the sea.

In those places where the Jura chain branches into the great valley between the Jura and the Alps, loose blocks are found in the valleys behind the projecting chains. The Jura range is sometimes intersected in places opposite to the Alps; and it is remarked, that loose blocks are met with in the valleys behind these intersected portions of the range; and that, when loose blocks occur in the Jura range, at a distance from the Alps, it is only in such places as are directly opposite to the intersected portions of the chain opposite to the Alps.

The circumstance of the non-occurrence of these blocks in the sandstone, marl, and nagelfluh, which occupy the great valley between the Alps and the Jura, proves that that revolution of our globe, by which these were dispersed, took place after the formation of these rocks, and may therefore have belonged to one of the latest changes which have contributed to the present form of the earth's surface.

When we compare the relations of the alluvium of the rivers in valleys with those of the loose blocks, their similarity must strike every one. Thus, rolled masses are seldom deposited in those places where a river forces its way through a narrow passage; but where an expansion takes place, owing to the distance of the banks increasing, the rolled masses are sometimes accumulated in whole banks. The same loose blocks seldom occur in the narrow passages of the transverse valleys in the Alps; but as soon as widenings of the valleys take place below these narrowings, the blocks occur in abundance.

If, during a flood, a rupture takes place in the banks of a river, where it is contracted, a part of the stream will flow out by the lateral opening, and carry along with it rolled masses, even when the opening in the bank does not reach to the bottom of the bed of the river; for the mountain stream, loaded with boulders, carries them not merely in single masses along its bottom, but the flood-water of the stream generally attacks large sandbanks, or older beds of rolled masses, and carries along with it, accompanied with a terrible noise, whole masses, forces them over the lower banks, or through the chasm in the bank, and often deposites them several feet high, on an immediately succeeding widening of the river's course.

In the same manner, we observe loose blocks deposited on high situations in the lateral valleys of the great transverse valleys, and dispersed over the passes into the neighbouring valleys. The height of the lateral deposites of loose blocks, and their position in the passes, and their passing into neighbouring valleys, are facts which assist us in judging of the extent of the power that may have acted during their transportation.

The striking agreement observable in the phenomena of the distribution of the loose blocks from the interior Alpine valleys to the interior valleys of the Jura, with those in the rolled masses carried along by rivers, must lead every one, who reflects on this interesting phenomenon, to the hypothesis, that these blocks may have been deposited in their present situations by an overwhelming flood, which burst from the Alps. It is true that this opinion is liable to many objections; but still it contains a more plausible explanation of the phenomenon than any other with which we are acquainted.

The loose blocks, in the different river-districts, being in general separated from each other, or if any intermixture takes place of the rolled masses of one valley with that of another, it being only on their edges, it is highly probable that the floods which burst from these valleys, and carried along with them the masses of rocks, may have been simultaneous, by which the flow of the one basin would bound and limit that of the other, and thus prevent the water-flood of one basin flowing into the neighbouring ones.

The contemporaneous occurrence of these different floods from the Alpine valleys, can alone, on this hypothesis, explain why this aqueous flood was so generally and so highly accumulated in the great valleys between the Alps and the Jura, as to reach the height of most of the sandstone mountains, and to a great elevation in the Jura, where many blocks are found deposited. But if the contemporaneous occurrence of these floods is proved by the facts already enumerated, to what cause are we to refer this simultaneous bursting of floods of water from so many Alpine valleys?

We observe, on the north-western side of the chain of the Alps, numerous openings, which, by their structure, seem to point out the action of violent floods. Let us suppose the numerous valleys, in the districts already described, closed at their present entrances, or openings, as would seem from their structure to have been formerly the case; the consequence of this arrangement would be the filling of the Alpine valleys with water, to the height of the lowest passes among the mountains, and thus an enormous accumulation of water would take place. This great body of water, if let loose at once, by the bursting of the lower extremities of the valleys, would form a flood which would sweep across the sandstone mountains, between the Alps and the Jura range, and even ascend high on the Jura itself. This flood of water, moving, probably, at the rate of 200 feet in a second, and loaded with debris of rocks, would carry masses, even these having a magnitude of 50,000 cubical feet, some thousand feet high, on the Jura range*. Geologists maintain, that the blocks or boulders met with in other countries, and arranged as those in Switzerland, have been deposited where we now find them, by the bursting of lakes; while those found on the shores of the Baltic, are conjectured to have been transported by a great rush of water caused by the sudden elevation of the land of Scandinavia. Another opinion has its advocates, which maintains that these boulders have been spread over different countries by the waters of the *deluge*.

Note F, p. 26.

ON THE ALLUVIAL LAND OF THE DANISH ISLANDS IN THE BALTIC, AND ON THE COAST OF SLESWIGH.

In this section, Cuvier gives a clear and distinct account of several kinds of alluvial formations. M. De Luc, in the first volume of his Geological Travels, describes the alluvial formations that cover and bound many of the islands in the Baltic, and upon the coast of Denmark, and gives so interesting an account of the modes followed by the inhabitants, in preserving these alluvial deposites, that we feel pleasure in communicating it to our readers.

---

* In Silliman's American Journal there are many interesting details in regard to the distribution of boulders in the northern parts of North America.

“ During my stay at Husum, I had the advantage of passing my evenings very agreeably and profitably at the house of M. Hartz, with his own family, and two Danish officers, Major Behmann, commandant at Husum, and Captain Baron de Barackow. The conversation often turned on the objects of my excursions, and particularly on the natural history of the *coasts* and of the *islands;* respecting which, M. Hartz obligingly undertook to give me extracts from the chronicles of the country. This led us to speak of the Danish islands; and those officers giving me such descriptions of them, as were very interesting to my object, I begged their permission to write down, in their presence, the principal circumstances which they communicated to me. These will form the first addition to my own observations; I shall afterwards proceed to the information which I obtained from M. Hartz.

The two principal islands of the Danish Archipelago, those of Funen and Seeland (or Zeeland), as well as some small islands in the Kattegate, namely, Lenoe, Anholt, and Samsoe, are hilly, and principally composed of *geest* *; and in these are found *gravel* and *blocks of granite*, and of other stones of that class, exactly in the same manner as in the country which I have lately described, and its *islands* in the North Sea. On the borders of the two first of these Danish islands, there are also *blocks* in the sea; but only in front of *abrupt* coasts, as is the case with the islands of Poel and Rugen, and along the coasts of the Baltic. The lands added to these islands of *geest* are in most part composed of the *sand* of the sea, the land-waters there being very inconsiderable; and to the south of them have been formed several islands of the same nature, the chief of which are Laland and Falster, near Seeland. These, like the marsh islands in the North Sea, are sand-banks accumulated by the waves, and, when covered with grass, continuing to be farther raised by the sediments deposited between its blades. In the Baltic, where there are no sensible tides, such islands may be inhabited without dikes, as well as the extensions of the coasts; because, being raised to the highest level of that sea, while their declivity under water is very small, and being also more firm in their composition, the waves die away on their shores; and if, in any extraordinary case, the sea rises over them, it leaves on them fresh deposits, which increase their heights. These soils are all perfectly *horizontal*, like those added to the coasts of the Continent.

---

* By *geest* is understood the alluvial matter which is spread over the surface both of the hilly and low country, and appears, according to De Luc, to have been formed the last time the waters of the ocean stood over the surface of the earth.—J.

Some of these islands approach entirely, or in part, to the nature of that of Rugen. This island of Seeland, on that side which is called Hedding, has a promontory composed of strata of *chalk* with its flints. The island of Moen (or Mona), on the south of the latter, has a similar promontory near Maglebye and Mandemark; and the island of Bornholm, the easternmost of those belonging to Denmark, contains strata of *coal*, covered by others of *sandstone*. Phenomena like these, evident symptoms of the most violent catastrophes at the bottom of the ancient sea, proceeding, as I think I have clearly shewn, from the subsidence and angular motions of large masses of strata, which must have forced out the interior fluids with the utmost impetuosity, it is not surprising that so many fragments of the lowermost strata are found dispersed over this great theatre of ruins.

I now proceed to the details which I received from M. Hartz; beginning by a specific designation of the *islands* dependent on the province of Sleswigh, such as they are at present, belonging to the three classes already defined. To commence from the north; Fanoe, Rom, Sylt, and Amrom, were originally *islands* of the same nature as the neighbouring continent, but have been since extended by *marsches*[*]. The soil of these islands, with its gravel and blocks of primordial stones, was at first barren, as the *geest* is naturally every where; but is become fertile by manure, of which there has been no deficiency, since those grounds have been surrounded with *marsch*, where the cattle are kept in stables during the winter. In the island of Sylt, there are spaces consisting of *moor*, but its head of land, which extends on the south as far as Mornum, is composed entirely of *marsch*, and is bordered with *dunes* towards the open sea, because, the sediments of the rivers not reaching any farther, the *sea-sand* impelled against it by the waves remains pure, and is thus raised by the winds in hillocks on the shore. The shallow bottom of the sea, between this island and that of Fora, is of *geest*: at low water, it may be passed over on foot; and there are found on it gravel and blocks of *granite*. But on the same side of Fora there is a great extent of *marsch*, beginning from St Laurencius. Among the islands consisting entirely of

---

[*] By *marsch*, according to De Luc, is understood the new land added o the coasts since the last retiring of the water of the globe from the urface of the earth, and is formed by the sediments of rivers, mixed more or less with sand from the bottom of the sea.—J.

marsch and surrounded with dikes, the most considerable are Pellworm and Nord Strand; and among the Halligs, or those inhabited without dikes, the chief are Olant, Nord-marsh, Langne, Groode, and Hooge.

Such are the islands on this coast, in their present state, now rendered permanent by the degree of perfection at which the art of dike-making is arrived. But, in former times, though the *original* land was never attacked by the *sea*, which, by adding to it *new lands*, soon formed a barrier against its own encroachments, the latter, and the *islands* composed of the same materials, were subject to great and sudden changes, very fatal to those who were engaged to settle on them by the richness of their soil, comparatively with the continental. The inhabitants, who continued to multiply on them during several generations, were taught, indeed, by experience, that they might at last be invaded by the element which was incessantly threatening them; but having as yet no knowledge of natural causes, they blindly considered those that endangered them as supernatural, and for a long time used no precautions for their own security. They were ignorant of the dreadful effects of a certain association of circumstances, rare indeed, but, when occurring, absolutely destructive of these *marsches*. This association consists of an extraordinary elevation of the level of the North Sea, from the long continuance of certain winds in the Atlantic, with a violent storm occurring during the tides of the new or full moon; for then the sea rises above the level of all the *marsches*; and before they were secured against such attacks, the waves rolling over them, and tearing away the grass which had bound their surface, they were reduced to the state of mere banks of sand and mud, whence they had been drawn, by the long course of ordinary causes. Such were the dreadful accidents to which the first settlers on these lands were exposed; but no sooner were they over, than ordinary causes began again to act; the sand-banks rose; their surface was covered with grass; the coast was thus extended, and new islands were formed; time effaced the impression of past misfortunes; and those among the inhabitants of these dangerous soils, who had been able to save themselves on the coast, ventured to return to settle on them again, and had time to multiply, before the recurrence of the same catastrophes.

This has been the general course of events on all the coasts of the North Sea, and particularly on those of the countries of Sleswigh and Holstein. It is thus that the origin and progress of the *art of dikes* will supply us with a very interesting *chronometer* in the history of the continent and of man, particularly exemplified in this part of the globe. A Lutheran clergyman, settled in the island of Nord Strand, having collected all the particulars of this history which the documents of the country could afford, published it in 1668, in a German work, entitled *The North Frisian Chronicle*. It was chiefly from this work, and from the *Chronicle of Dankwerth*, that M. Hartz extracted the information which he gave to me, accompanied by two maps, copied for me, by one of his sons, from those of Johannes Mayerus, a mathematician; they bear the title of *Frisia Cimbrica;* one of them respecting the state of the *islands* and of the *coast*, in 1240, as it may be traced in the chronicles, and the other, as it was in 1651.

According to these documents, the first inhabitants of the *marsches* were *Frisii* or *Frisians*, designated also under the names of *Cimbri* and *Sicambri:* the latter name, M. Hartz conjectures, might come from the ancient German words *Seekampfers*, i. e. *Sea-warriors*; the *Frisians* being very warlike. These people appear to have had the same origin with those, who, at a rather earlier period, took possession of the *marsches* of Ost-Frise (East-Friesland), and of that Friesland which forms one of the United Provinces; but this common origin is very obsure. Even at the present day, the inhabitants of the *marsches*, from near Husum to Tondern, or Tunder to the North, though themselves unacquainted with it, speak a language which the other inhabitants of the country do not understand, and which is supposed to be Frisian. It is the same at a village in the peninsula of Bremen, by which I have had occasion to pass.

The *Sicambri* or *North Frisians*, are traced back to some centuries before the Christian era. At the commencement of that era, they were attacked by Frotho, King of Denmark, and lost a battle, under their king Vicho, near the river Hever. Four centuries afterwards they joined the troops of Hengist and Horsa. In the year 692, their king Radebot resided in the island of Heiligeland. Charles Martel subdued them in 732; and some time afterwards they joined Charlemagne against Gottric, King of Denmark. These are some of the circumstances of the history of this Frisian colony, recorded in the chronicles of which I have spoken; but the history here interesting to us is that of the lands whereon they settled.

It appears that these people did not arrive here in one body, but successively, in the course of many years: they spread themselves over various parts of the coasts of the North Sea, and even a considerable way up the borders of the Weser and the Elbe; according to documents which I have mentioned in my *Letters sur l'Histoire de la Terre et de l'Homme.* These new settlers found large *marsches*, formed, as well in the wide mouths of those rivers as along the coasts, and around the original islands of *geest*; especially that of Heiligeland, the most distant from the coast, and opposite the mouth of the Eyder. Of this island, which is steep towards the south, the original mass consists of strata of *sandstone*; and at that time its *marsch* extended almost to Eyderstede: there were *marsches* likewise around all the other original islands; besides very large islands of pure *marsch* in the intervals of the former.

All these lands were desert at the arrival of the Frisians; and the parts on which they established their first habitations, to take care of their breeds of horses and cattle feeding on the *marsches*, were the original eminences of the islands; on that of Heiligeland they built a temple to their great goddess Phoseta, or Fosta. When they became too numerous to confine themselves to the heights, their herds being also greatly multiplied, they ventured to begin inhabiting the *marsches*; but afterwards, some great inundations having shewn them the dangers of that situation, they adopted the practice followed by those who had settled on the *marsches* of the province of Groningen, and still continued on the Halligs; that of raising artificial mounts called *werfs*, on which they built their houses, and whither they could, upon occasion, withdraw their herds; and it likewise appears, that, in the winter, they assembled in greater numbers on the spots originally the highest, in the islands, as well as on some parts of the coasts.

Things continued in this state for several centuries; during which period, it is probable that the inhabitants of these lands were often, by various catastrophes, disturbed in the enjoyment of them, though not discouraged. But in 516, by which time these people were become very numerous, more than 600 of them perished by one of the concurrences of fatal circumstances already defined. It was then that they undertook the astonishing enterprise of enclosing these lands. They dug ditches around all the *marsches*, heaping up on their exterior edge the earth which was taken out; and thus they opposed to the sea, dikes of eight feet in height. After this, comprehending that nothing could contribute more to the safety of their dwellings, than to remove the sea to a greater distance, they undertook, with that view, to exclude it from the intervals between the islands, by uniting, as far as should be possible, those islands with each other. I will describe the process by which they effected this, after I shall have recalled to attention some circumstances leading to it.

From all that I have already said of the *fore-lands*, and of the manner in which they are increased, it may be understood, that the common effects of the *waves* and of the *tides* is to bring materials from the bottom of the sea towards the coasts; and that the process continues in every state of the sea. The land winds produce no *waves* on the coasts, which can carry back to the bottom of the sea what has been brought thence by the winds blowing against the shore; and as for the *tides*, it may have been already comprehended (and shall soon be proved), that the *ebb* carries back but very little of what has been brought by the *flood*. So that, but for some extraordinary circumstances, the materials continually impelled towards the shore, which first form islands, would at last unite against the coast in a continuous soil. The rare events, productive of great catastrophes, do not carry back these materials towards the bottom of the sea; they only, as it has been said before, ravage the surface, diminishing the heights, and destroying the effect of vegetation. These, then, were the effects against which it was necessary to guard.

I now come to the plan of uniting the *islands*, formed by these early inhabitants. They availed themselves for that purpose of all such parts of the sand-banks as lay in the intervals between the large islands, and were beginning to produce grass. These, when surrounded with dikes, are what are called *Hoogs*; and their effects are to break the waves, thus diminishing their action against the dikes of the large islands, and, at the same time, to determine the accumulation of the mud in the intervals between those islands. In this manner a large *marsch* island, named Everschop, was already, in 987, united to Eyderstede by the point on which Poppenbull is situated; and in 995, the union of the same *marsches* was effected by another point, namely, that of Tetenbull. Lastly, in the year 1000, Eyderstede received a new increase by the course of the Hever, prolonged between the sand banks, being fixed by a dike; but the whole still remained an *island*. This is an example of the manner in which the *marsch* islands were united by the *hoogs*; and the chronicle of the country says, that, by these labours, the islands were so considerably enlarged in size, and the intervals between them so much raised, that, at low water, it was possible to pass on foot from one to the other. The extent of these *marsches* was so great on the coast of Sleswigh alone, that they were divided into three provinces, two of which comprehended the islands, and the third comprised the *marsches* contiguous to the coast; and the same works were carried on upon the *marsches* of the coast of Holstein.

But the grounds thus gained from the sand-banks were very insecure; these people, though they had inhabited them more than ten centuries, had not yet understood the possibility of that combination of fatal circumstances above described, against which their dikes formed but a very feeble rampart; the North Sea, by the extraordinary elevations of its level, being much more formidable in this respect than the ocean, where the changes of absolute level are much less considerable. I shall give an abridged account of the particulars extracted by M. Hartz from the chronicle of Dankwerth, relative to the great catastrophes which these *marsches* successively underwent, previously to the time when experience led to the means necessary for their security.

In 1075, the island of Nord Strand, then contiguous to the coast, particularly experienced the effect of that unusual combination of destructive causes; the sea passing over its dike, and forming within it large excavations like lakes. In 1114 and 1158, considerable parts of Eyderstede were carried away; and in 1204, the part called Sudhever in the *marsch* of Uthholm was destroyed. All these catastrophes were fatal to many of the *marsch* settlers; but in 1216, the sea having risen so high that its waves passed over Nord Strand, Eyderstede, and Ditmarsch, near 10,000 of their inhabitants perished. Again, in 1300, seven parishes in Nord Strand and Pellworm were destroyed; and in 1338, Ditmarsch experienced a new catastrophe, which swept away a great part of it on the side next Eyderstede: the dike of the course of the Eyder between the sand-banks was demolished, and the tides have ever since preserved their course throughout that wide space. Lastly, in the year 1362, the isles of Fora and Sylt, then forming but one, were divided, and Nord Strand, then a *marsch* united to the coast, was separated from it.

During a long time, the inhabitants who survived these catastrophes, and their successors, were so much discouraged, that they attempted nothing more than to surround with *dikes* like the former such spaces of their meadow-land as appeared the least exposed to these ravages, leaving the rest to its fate. But the common course of causes continually tending to extend and to raise the grassy parts of the sand-banks, and no extraordinary combination of circumstances having interrupted these natural operations, later generations, farther advanced in the arts, undertook to secure to themselves the possession of those new grounds. In 1525, they turned their attention to the indentations made, during the preceding catastrophes, in the borders of the *marsches;* the waves, confined in these narrow spaces, sometimes threatening to cut their way into the interior part. In the front of all the creeks of this kind they planted stakes, which they interlaced with osiers, leaving a certain space between the lines. The waves, thus broken, could no longer do injury to the *marsch*; and their sediments being deposited on both sides of this open fence, very solid *fore-lands* were there formed. In 1550, they raised the *dikes* considerably higher, employing wheelbarrows, the use of which was only then introduced. For this purpose, they much enlarged and deepened the interior canals, in order to obtain more earth, not merely to add to the height of the dikes, but to extend their base on the outer side. At last they began to cover these dikes with straw-ropes; but this great preservative of dikes was at first ill managed; and the use of it was so slowly spread, that it was not adopted in North Strand and in Eyderstede, till about the years 1610 and 1612.

Before that time, however, the safety of the extensive soil of the latter *marsch* had been provided for in a different manner. I have said above, that, when the isles of Everschop and Utholm had been united to it, the whole together still formed but one large *island*; now, in this state, it was in as great danger on the side towards the continent, as on that open to the sea; because two small rivers, the Trene and the Nord Eyder, discharging themselves into the interval between it and the land, and by preserving their course to the sea, this interval was thus kept open to tempest, sometimes from the side of the Hever, sometimes from that of the Eyder; and the waves, beating against the *geest*, were thence repelled upon the *marsch*. The inhabitants, seeing that the expence of remedying these evils would be greater than they could afford, while at the same time it was indispensable to their safety, addressed themselves to their bishop and to their prefect, of whom they requested pecuniary assistance; and having obtained it they first undertook the great enterprise of carrying the Trene and the Nord Eyder higher up into the Eyder; keeping their waters, however, still separate for a certain space, by a *dam* with a *sluice*, in order to form there a reservoir of fresh water; the tides ascending up the Eyder above Frederickstadt. They were thus enabled to carry on the extremities of the *dike* on both sides to join the *geest*; and the interval between the latter and the *marsch* was then soon filled up, there being only left at their junction the canal above described which receives the water of the *geest*, and, at low water, discharges them from both its extremities by sluices. At the same time, the islands of Pelworm and Nord Strand were united with each other by means of eight *hoogs*; and the *sandy marsches* of which I have spoken, contiguous to the *geest*, on the north of that of Husum, were inclosed with dikes.

After the dikes had been thus elevated, and their surface rendered firm by the straw ropes, though the latter were not yet properly fixed, the inhabitants of the *marsches* for some time enjoyed repose; but on the 11th October 1634, the sea, rising to an excessive height, carried away, during a great tempest, the *hoogs* which had produced the junction between Pellworm and Nord Strand, these having ever since continued distinct islands; it also violently attacked Ditmarsch; and its ravages extended over the whole coast, as far as the very extensive new lands of Jutland. Princes then came forward zealously to the relief of their subjects. In particular, Frederick III., Duke of Sleswigh, seeing that the inhabitants of Nord Strand were deficient both in the talents and in the means necessary for the reparation and future security of that large island, and knowing that the art of dikes had made greater progress in Holland, because of the opulence of the country, addressed himself to the States-General, requesting them to send him an engineer of dikes, with workmen accustomed to repair them; and this was granted. The dikes of Nord Strand were then repaired in the most solid manner; and the Dutch engineer, seeing the fertility of its soil, advised his sons upon his death-bed, to purchase lands and settle there, if the Duke would grant them the free exercise of their religion; they being Jansenist catholics, and the inhabitants of the island Lutherans. The Duke agreed to this, on condition that they and their posterity should continue to superintend the works carried on upon the dikes; to which they engaged themselves. From that time the art of dikes, and particularly that part of it which consists in covering them solidly with straw, has become common to all the *marsches;* and the Dutch families, which have contributed to this fortunate change, continue to inhabit the same island, and to enjoy the free exercise of their religion."

NOTE G, p. 28.

ON THE SAND-FLOOD.

In different parts of Scotland, as in Aberdeenshire, Hebrides, and Shetland Islands, there are examples of the natural chronometer mentioned in the text. In Morayshire there is a striking example of the sand-flood, concerning which the following details have been furnished by my young friend the Rev. Mr Ritchie.

Sand-Flood in Morayshire.

"Westward from the mouth of the river Findhorn in Morayshire, a district, consisting of upwards of ten square miles of land, which, owing to its extreme fertility, was once termed the Granary of Moray, has been depopulated and rendered utterly unproductive by the sand-flood. This barren waste may be characterised as hilly; the accumulations of sand composing these hills frequently varying in their height, and changing their situation.

There is historical evidence, that, in the year 1097, the Moray Firth overflowed the low country on its southern shore, and threw out sand. But the destruction of the barony of Coubine (which includes the greater part of the desert mentioned above) was long subsequent to this, as might be proved from the inscription on a tombstone in the church yard of Dyke. From historical notices, also, in regard to the Kinnairds of Coubine, preparing for publication, it appears that the eruption of sand commenced about the year 1677; that its progress was gradual; that, in 1697, not a vestige was to be seen of the manor-place, orchards, and offices of Coubine; that two-thirds of the barony were already ruined, and that the sand was daily gaining ground.

This sand, which overwhelmed Coubine, came from Mavieston, situated on the shore, about seven miles west from the mouth of the Findhorn, where, from time immemorial, there have been large accumulations of sand. The sands at Mavieston had formerly been covered with vegetation. In an act of the Scottish Parliament, dated 16th July 1695, for the preservation of lands adjacent to sand-hills, it is stated, that the destruction of Coubine "was occasioned by the bad practice of pulling bent and juniper." Having been thus set at liberty, the sand moved towards the north-east, as appears from the desolation which marks its progress. The moving cause is the wind. I have had opportunities of witnessing the effect of the wind on the loose sand. When the breeze is moderate it carries along with it successive waves of sand, each wave (if I may be allowed the expression) being of a small size, and moving with greater or less velocity, in proportion to the strength of the breeze, and presenting a very beautiful appearance. When the wind is high the heavier particles are drifted forwards, the more minute are raised to a considerable height in the atmosphere, occasioning no small inconvenience to the spectator, who finds his ears and nostrils filled with sand. The movements of the sand are still towards the north-east. In the winter of 1816 a large portion of Binsness, the only remaining farm on the west side of the Findhorn, situated in the line of the sand's progress, was overwhelmed. Since that period large accumulations of sand have disappeared altogether, and rich soil, marked with the plough, has been left bare, after having been buried for upwards of a century.

The very minute particles, which, as has been stated, the wind raises to a considerable height, are occasionally carried across the Bay of Findhorn. In the statistical account of Dyke, the parish in which Coubine is situated, it is said, "that, at the town of Findern, in a blowing day, one may feel the sand sharply striking on his face, from the west side." This sand, of extreme fineness, is to be seen in and around the town of Findhorn, and along the coast much rich land is said to have been covered by sand brought from the west.

The greater quantity of the sand is drifted into the river, and its effects have been very remarkable. Many years ago the mouth of the river having become blocked up with sand, it cut out for itself its present channel, which conducts it, by a more direct course, to the sea. In consequence of this, the old town of Findhorn had changed its situation, from the east to the west side of the river, and its site has since been covered by the sea. Previous to this, however, the inhabitants, carrying with them the stones of their former houses, had removed across the river, and erected the present village. On the retiring of the tide from the bay, the river almost disappears, being swallowed up by the sand, and quick-sands are formed. The effect resulting from the same cause, the drifting in of the sand is very different at high water. In consequence of the channel of the river having been filled up, the bay has increased in breadth. The sand constantly carried down by the river has formed a bar, which prevents the entrance of large vessels; and the river, probably owing to its increased breadth, and this bar depriving it of the impetus acquired in the course of its descent, is, at spring-tides, unable to force its way into the sea, when it is made to flow back, and inundate a considerable extent of carse-land situated at the head of the bay. It was at one time proposed to render the river navigable by dredging. And it is proposed to endeavour to save the adjoining carse-land, which is of the richest quality, from the monthly inundation to which it is at present subject, by building a wall along the river side.

I venture to suggest, that the plan Nature employs for fettering down sand should first be imitated, and that seeds of the Arundo arenaria, Elymus arenarius, and other plants, which grow readily in sand, should be, from time to time, strewed over the Mavieston Hills. The seeds of the Arundo arenaria are not always to be had; but plants might easily be procured in abundance, and be dibbled into the sand-hills. The circumstance of great accumulations of sand having of late disappeared from Coubine, has given rise to the expectation, that the barony is at no distant period to become again serviceable to man. By cutting off fresh supplies from Mavieston, this period would be accelerated, and the proposed improvements rendered comparatively easy.

There is at present little bent on Coubine. It is chiefly confined to a range of knolls, which forms the southern boundary of the sand, and protects the adjoining cultivated fields from its encroachments; and yet, notwithstanding the terrible calamity the inhabitants of Moray brought upon themselves, by the pulling of bent, this "bad practice" still prevails; this plant being in no other district of country which I have visited so generally employed for thatching cottars' houses, and other economical purposes."

In the Outer Hebrides the effects of the sand-flood are also considerable, as shewn in the following notice communicated by my intelligent assistant Mr Macgillivray.

Sand-Flood in the Hebrides, and other parts of Scotland.

" The bottom of the sea, along the whole west coast of the Outer Hebrides, from Barray Head to the Butt of the Lewis, appears to consist of sand. Along the shores of these islands this sand appears here and there, in patches of several miles, separated by intervals of rock, of equal or greater extent. In some places the sandy shores are flat, or very gently sloping, forming what are here called Fords; in others, behind the beach, there is an accumulation of sand to the height of from twenty to sixty feet, formed into hillocks. This sand is constantly drifting; and in several places islands have been formed by the removal of isthmi. The parts immediately behind the beach are also liable to be inundated by the sand; and in this manner most of the islands have suffered very considerable damage. Those of Pabbay and Berneray in Harris may be particularised; in the former of which, a tract of about a mile and a-half long, by half a mile in breadth, has been converted into a desert of drifting sand; and in the latter a large plain, that was formerly noted for its fertility, has been entirely swept away. The sand consists almost entirely of comminuted shells, apparently of the species which are found in the neighbouring seas. It is rather coarse in the grain; but, during high winds, by the rubbing of its particles upon each other, a sort of dust is formed, which, at a distance, resembles smoke, and which, in the Island of Berneray, I have seen driven into the sea, to the distance of upwards of two miles, appearing like a thin white fog. The cure of sand drift has been attempted in these islands in two different ways. Mr Alexander Macleod, surgeon of North Uist, is the inventor of the most efficacious method, which is that of cutting thin square turfs from the neighbouring pasture grounds, and laying them down at intervals of some inches. In the course of a very few years the turfs coalesce, and the stript ground is little the worse; for the roots remaining in it, a new vegetation rapidly springs up. The other method was introduced by Mr Macleod of Harris, and tried extensively upon his estate. It consists of planting small bundles of Arundo arenaria, at distances of about a foot and a-half. These take root, and prevent the drifting to a certain degree. But often vegetation is tardy in establishing itself, and if the turf plan be not considerably more expensive, it seems preferable, because it very effectually prevents the drift, and moreover, produces excellent pasture ground; the former of which indications, the planting system, does not completely effect, and the latter in a very imperfect degree."

We may add, as this subject is a very interesting one, that further details, in regard to the moving sands of Scotland, will be found, on consulting the Statistical Account of Scotland, vol. xx. p. 220. In the Appendix to the Account of the parish of Dyke, vol. xx. p. 228. *et seq.* there is an account of the Sand-Hills of Maviston, which overwhelmed the barony of Coubine, as mentioned in Mr Ritchie's communication. In vol. xix. p. 622. is a notice of the shifting of two hills of the Mavieston Range 500 yards in twenty years. In vol. xxi. p. 207., is a notice of some hundred acres in Duffus' parish covered three feet deep by drift sand; fourteen inches accumulating in one night. In Neill's Tour in Orkney and Shetland 1804, it is observed, that, in the neighbourhood of the Castle of Noltland, in Westra, much havoc has been done by the blowing of the sand. No measures are there employed for putting a stop to this kind of devastation. In the 6th volume of the Highland Society's Transactions will be found a report of the operations carried on in Harris, and alluded to in Mr Macgillivray's communication. And in Dr Walker's Account of the

Hebrides, and Mr Macdonald's Work on the Hebrides; farther details may be seen. In Jameson's Account of the Shetland Islands, and in Shirreff and Fleming's Reports on these islands, are also facts connected with this devastating agent. We may add, that Dr Oudney, Major Denham, and Captain Clapperton, have added to our knowledge of the blowing sands of the African deserts. The coloured engraving of the sand-hills of the African Desert in Denham, Oudney and Clapperton's Narrative, is a striking and interesting representation of the form of the moving sand-hills of Africa.

The moving Sands of Africa and their effects are thus described in the Mercure de France *for September* 1809, *by De Luc.*

The sands of the Lybian desert, he says, driven by the west winds, have left no lands capable of tillage on any parts of the western banks of the Nile not sheltered by mountains. The encroachment of these sands on soils which were formerly inhabited and cultivated is evidently seen. M. Denon informs us, in the account of his *Travels in Lower and Upper Egypt*, that summits of the ruins of ancient cities buried under these sands still appear externally; and that, but for a ridge of mountains called the *Lybian chain*, which borders the left bank of the Nile, and forms, in the parts where it rises, a barrier against the invasion of these sands, the shores of the river, on that side, would long since have ceased to be habitable. Nothing can be more melancholy, says this traveller, than to walk over villages swallowed up by the sand of the desert, to trample under foot their roofs, to strike against the summits of their minarets, to reflect that yonder were cultivated fields, that there grew trees, that here were even the dwellings of men, and that all has vanished.

If, then, our continents were as ancient as has been pretended, no traces of the habitation of men would appear on any part of the western bank of the Nile, which is exposed to this scourge of the sands of the desert. The existence, therefore, of such monuments attests the successive progress of the encroachments of the sand: and those parts of the bank, formerly inhabited, will for ever remain arid and waste. Thus the great population of Egypt, announced by the vast and numerous ruins of its cities, was in great part due to a cause of fertility which no longer exists, and to which sufficient attention has not been given. The sands of the desert were formerly remote from Egypt; the *Oases*, or habitable spots, still appearing in the midst of the sands, being the remains of the soils formerly extending the whole way to the Nile; but these sands, transported hither by the western winds, have overwhelmed and buried this extensive tract, and doomed to sterility a land which was once remarkable for its fruitfulness.

It is therefore not solely to her revolutions and changes of sovereigns that Egypt owes the loss of her ancient splendour; it is also to her having been thus irrecoverably deprived of a tract of land, by which, before the sands of the desert had covered it, and caused it to disappear, her wants had been abundantly supplied. Now, if we fix our attention on this fact, and reflect on the consequences which would have attended it if thousands, or only some hundreds, of centuries had elapsed since our continents first existed above the level of the sea, does it not evidently appear that all the country on the west of the Nile would have been buried under this sand before the erection of the cities of ancient Egypt, how remote soever that period may be supposed; and that in a country so long afflicted with sterility, no idea would even have been formed of constructing such vast and numerous edifices? When these cities indeed were built, another cause concurred in favouring their prosperity. The navigation of the Red Sea was not then attended with any danger on the coasts; all its ports, now nearly blocked up with *reefs of coral*, had a safe and easy access; the vessels laden with merchandize and provisions could enter them and depart without risk of being wrecked on these shoals, which have risen since that time, and are still increasing in extent.

The defects of the present government of Egypt, and the discovery of the passage from Europe to India round the Cape of Good Hope, are therefore not the only causes of the present state of decline of this country. If the sands of the desert had not invaded the bordering lands on the west, if the work of the sea polypi in the Red Sea had not rendered dangerous the access to its coasts and to its ports, and even filled up some of the latter, the population of Egypt and the adjacent countries, together with their product, would alone have sufficed to maintain them in a state of prosperity and abundance. But now, though the passage to India by the Cape of Good Hope should cease to exist, though the political advantages which Egypt enjoyed during the briliant period of Thebes and Memphis should be re-established, she could never again attain the same degree of splendour.

Thus the reefs of coral which had been raised in the Red Sea on the east of Egypt, and the sands of the desert which invade it on the west, concur in attesting this truth: That our continents are not of a more remote antiquity than has been assigned to them by the sacred historian in the book of Genesis, from the great era of the deluge.

NOTE H, p. 30.

Action of the Sea upon Coasts.

THE ocean, in its action upon the cliffs and banks situated on the coast, breaks them down to a greater or less extent, and either accumulates the debris at their basis in the form of sea beaches of greater or less magnitude, or by currents carries it away to be deposited upon other shores, or to give rise to sand-banks near the coast, which, in the course of time, become united to the land, and thus secure it from the further action of the sea. These *destroying* and *forming* effects of the waters of the ocean are to be observed all around the coasts of this island; and beautiful examples of such actions are to be seen on the coasts of Ireland, and in many of the islands that lie to the west and north of Great Britian. In a paper read before the Wernerian Natural History Society, Mr Stevenson, engineer, mentions many facts illustrative of the destroying effects of the ocean on our coasts.—Thus he informs us that the waters of the sea are wearing away the land upon both sides of the Frith of Forth, not only in exposed, but also in sheltered situations, and the solid strata, as well as the looser alluvial formations, which owe their origin to the destroying agency of the ocean at a former period, are again yielding to its action. At Saint Andrew's, the famous castle of Cardinal Beaton, which is said originally to have been some distance from the sea, now almost overhangs it: From St Andrew's northward to Eden water and the River Tay, the coast presents a sandy beach, and is so liable to shift, that it is difficult to trace the change it may have undergone. It is certain, however, that, within this last century, the sea has made such an impression upon the sands of Barrey, on the northern side of the Tay, that the light-houses at the entrance of the river, which were formerly erected at the southern extremity of Button-ness, have been from time to time removed about a mile and a quarter further northward, on account of the wasting and shifting of these sandy shores, and that the spot on which the outer light-house stood in the 17th century, is now two or three fathoms under water, and is at least three quarters of a mile within flood-mark.

NOTE, p. 32.

On the growth of Coral Islands.

Of all the genera of lithophytes, the madrepore is the most abundant. It occurs most frequently in tropical countries, and decreases in number and variety as we approach the poles. It encircles in prodigious rocks and vast reefs many of the basaltic and other rocky islands in the South Sea and Indian Ocean, and, by its daily growth, adds to their magnitude. The coasts of the islands in the West Indies, also those of the islands on the east coast of Africa, and the shores and shoals of the Red Sea, are encircled and incrusted with rocks of coral.

Several different tribes of madrepore contribute to form these coral reefs; but by far the most abundant are those of the genera carophylla, astrea and meandrina. These lithophytic animals not only add to the magnitude of land already existing, but, according to some naturalists, they form whole islands. Dr Forster, in his Observations made during a Voyage round the World, gives an account of the formation of these coral islands in the South Sea.

All the low isles, he says, seem to me to be a production of the sea, or rather its inhabitants, the polype-like animals forming the lithophytes. These animalcules raise their habitation gradually from a small base, always spreading more and more, in proportion as the structure grows higher. The materials are a kind of lime mixed with some animal substances. I have seen these large structures in all stages, and of various extent. Near Turtle Island, we found, at a few miles distance, and to leeward of it, a considerable large circular reef, over which the sea broke every where, and no part of it was above water; it included a large deep lagoon. To the east and north-east of the Society Isles, are a great many isles, which in some parts are above water; in others, the elevated parts are connected by reefs, some of which are dry at low water, and others are constantly under water. The elevated parts consist of a soil formed by a sand of shells and coral rocks, mixed with a light black mould, produced from putrified vegetables, and the dung of sea-fowls; and are commonly covered by cocoa-nut trees and other shrubs, and a few antiscorbutic plants. The lower parts have only a few shrubs and the above plants; others still lower, are washed by the sea at high-water. All these isles are connected, and include a lagoon in the middle, which is full of the finest fish; and sometimes there is an opening, admitting a boat or canoe, in the reef, but I never saw or heard of an opening that would admit a ship.

The reef, or the first origin of these isles, is formed by the animalcules inhabiting the lithophytes. They raise their habitation within a little of the surface of the sea, which gradually throws shells, weeds, sand, small bits of corals, and other things, on the tops of these coral rocks, and at last fairly raises them above water; where the above things continue to be accumulated by the sea, till by a bird, or by the sea, a few seeds of plants that commonly grow on the sea-shore, are thrown up, and begin to vegetate; and by their annual decay and reproduction from seeds, create a little mould, yearly accumulated by the mixture with sand, increasing the dry spot on every side; till another sea happens to carry a cocoa-nut hither, which preserves its vegetative power a long time in the sea, and therefore will soon begin to grow on this soil; especially as it thrives equally in all kinds of soil; and thus may all these low isles have become covered with the finest cocoa-nut trees.

The animalcules forming these reefs want to shelter their habitation from the impetuosity of the winds, and the power and rage of the ocean; but as, within the tropics, the winds blow commonly from one quarter, they, by instinct, endeavour to stretch only a ledge, within which is a lagoon, which is certainly entirely screened against the power of both. This, therefore, might account for the method employed by the animalcules in building only narrow ledges of coral rocks, to secure in their middle a calm and sheltered place; and this seems to me to be the most probable cause of the origin of all the Tropical Low Isles, over the whole South Sea.

That excellent navigator, the late Captain Flinders, gives the following interesting account of the formation of Coral Islands, particularly of Half-way Island on the north coast of Terra Australis *.

" This little island, or rather the surrounding reef, which is three or four miles long, affords shelter from the south-east winds; and being at a moderate day's run from Murray's Isles, it forms a convenient anchorage for the night to a ship passing through Torres' Strait: I named it *Half-way Island*. It is scarcely more than a mile in circumference, but appears to be increasing both in elevation and extent. At no very distant period of time, it was one of those banks produced by the washing up of sand and broken coral, of which most reefs afford instances, and those of Torres' Strait a great many. These banks are in different stages of progress: some, like this, are become islands, but not yet habitable; some are above high-water mark, but destitute of vegetation; whilst others are overflowed with every returning tide.

" It seems to me, that, when the animalcules which form the corals at the bottom of the ocean cease to live, their structures adhere to each other, by virtue either of the glutinous remains within, or of some property in salt water; and the interstices being gradually filled up with sand and broken pieces of coral washed by the sea, which also adhere, a mass of rock is at length formed. Future races of these animalcules erect their habitations upon the rising bank, and die in their turn, to increase, but principally to elevate, this monument of their wonderful labours. The care taken to work perpendicularly in the early stages, would mark a surprising instinct in these diminutive creatures. Their wall of coral, for the most part, in situations where the winds are constant, being arrived at the surface, affords a shelter, to leeward of which their infant colonies may be safely sent forth; and to this, their instinctive foresight, it seems to be owing, that the windward side of a reef exposed to the open sea, is generally, if not always, the highest part, and rises almost perpendicular, sometimes from the depth of 200, and perhaps many more fathoms. To be constantly covered with water, seems necessary to the existence of the animalcules, for they do not work, except in holes upon the reef, beyond low-water mark; but the coral, sand, and other broken remnants thrown up by the sea, adhere to the rock, and form a solid mass with it, as high as the common tides reach. That elevation surpassed, the future remnants, being rarely covered, lose their adhesive property; and remaining in a loose state, form what is usually called a *key*, upon the top of the reef. The new bank is not long in being visited by sea-birds: salt plants take root upon it, and a soil begins to be formed; a cocoa-nut, or the drupe of a pandanus, is thrown on shore; land birds visit it, and deposit the seeds of shrubs and trees; every high tide, and still more every gale, adds something to the bank; the form of an island is gradually assumed; and last of all comes man to take possession.

---

* Vol. II. p. 114, 115, 116.

" Half-way Island is well advanced in the above progressive state; having been many years, probably some ages, above the reach of the highest spring tides, or the wash of the surf in the heaviest gales. I distinguished, however, in the rock which forms its basis, the sand, coral, and shells, formerly thrown up, in a more or less perfect state of cohesion. Small pieces of wood, pumice stone, and other extraneous bodies which chance had mixed with the calcareous substances when the cohesion began, were inclosed in the rock; and in some cases were still separable from it without much force. The upper part of the island is a mixture of the same substances in a loose state, with a little vegetable soil; and is covered with the *casuarina* and a variety of other trees and shrubs, which give food to parroquets, pigeons, and some other birds; to whose ancestors, it is probable, the island was originally indebted for this vegetation."

Mr Chamisso, who accompanied Kotzebue in his voyage, has published interesting observations on this subject. He informs us that the low islands of the South Sea and Indian Ocean owe their origin principally to the operations of several species of coral. Their situation with respect to each other, as they often form rows, their union in several places in large groups, and their total absence in other parts of the same seas, induce us to conclude, that the corals have founded their building on shoals of the sea; or, to speak more correctly, on the tops of mountains lying under water. On the one side, as they increase, they continue to approach the surface of the sea, on the other side they enlarge the extent of their earth. The larger species of corals, which form blocks, measuring several fathoms in thickness, seem to prefer the more violent surf on the external edge of the reef; this, and the obstacles opposed to the continuation of their life, in the middle of a broad reef, by the amassing of the shells abandoned by the animals, and fragments of corals, are probably the reason that the outer edge of the reef first approaches the surface. As soon as it has reached such a height, that it remains almost dry at low water, the corals leave off building higher; sea-shells, fragments of coral, shells of echini, and their broken off prickles, are united by the burning sun, through the medium of the cementing calcareous sand, which has arisen from the pulverization of the above mentioned shells into one whole or solid stone, which, strengthened by the continual throwing up of new materials, gradually increases in thickness till it at last becomes so high, that it is covered only during some seasons of the year by the high tides. The heat of the sun so penetrates the mass of stone when it is dry, that it splits in many places, and breaks of in flakes. These flakes, so separated, are raised one upon another by the waves at the time of high water. The always active surf throws blocks of coral, (frequently of a fathom in length, and three or four feet thick,) and shells of marine animals, between and upon the foundation stones; after this the calcareous sand lies undisturbed, and offers to the seeds of trees and plants, cast upon it by the waves, a soil upon which they rapidly grow, to overshadow its dazzling white surface. Entire trunks of trees, which are carried by the rivers from other countries and islands, find here, at length, a resting place after their long wanderings; with them come some small animals, such as lizards and insects, as the first inhabitants. Even before the trees form a wood, the real sea-birds nestle here; strayed land-birds take refuge in the bushes; and at a much later period, when the work has been long since completed, man also appears, builds his hut on the fruitful soil formed by the corruption of the leaves of the trees, and calls himself lord and proprietor of this new creation.

In the preceding account, we have seen how the exterior edge of a submarine coral edifice first approaches the surface of the water, and how this reef gradually assumes the properties of land; the island, therefore, necessarily has a circular form, and in the middle of it an inclosed lake. This lake, however, is not entirely inclosed; (and it could not be, for without supply from the sea it would soon be dried up by the rays of the sun,) but the exterior wall consists of a great number of smaller islands, which are separated from each other by sometimes larger, sometimes smaller spaces. The number of these islets amounts, in the larger coral islands, to sixty; and between them it is not so deep but that it becomes dry at the time of ebb. The interior sea has in the middle generally a depth of from thirty to five-and-thirty fathoms; but on all sides towards the land the depth gradually increases. In those seas where the constant monsoons prevail, where, consequently, the waves beat only on one side of the reef or island, it is natural that this side of the reef, exposed to the unremitting fury of the ocean, should be formed chiefly by broken-off blocks of coral, and fragments of shells, and first rise above the elements that created it. It is only these islands respecting the formation and nature of which we hitherto know any thing with certainty; we are almost entirely without any observations on those in the Indian and Chinese Sea, which lie in the regions of the six months' monsoons. From the charts given of them, it is to be inferred that every side is equally advanced in formation. The lee side of such a coral reef in the Pacific Ocean, which is governed by the constant monsoons, frequently does not shew itself above the water, when the opposite side, from time immemorial, has attained perfection in the atmospheric region; the former reef is even interrupted in many places by intervals tolerably broad, and of the same depth as the inner sea, which have been left by nature, like open gates, for the exploring mariner to enter the internal calm and secure harbour. In their external form the coral islands do not resemble each other; but this, and the extent of each, probably depends on the size of the submarine mountain tops, on which their basis is founded. Those islands which have more length than breadth, and are opposed in their greatest extent to the winds and waves, are richer in fruitful islets than those whose situation is not so adapted to a quick formation. In the large island-chains, there are always some single islets which have the appearance of high land; these lie upon an angle projecting into the sea, are exposed to the surf upon two sides, consist therefore almost entirely of large blocks of coral, and are destitute of smaller fragments of shells and coral sand to fill up the intervals. They are, therefore, not adapted to support plants requiring a depth of soil, and only afford a basis to high trees, provided with fibrous roots, (as the Pisonia, Cordia Sebastiana, L.; Morinda citrifolia, L.; and Pandanus odoratissimus, L.), which, at a distance, give to these, always very small islands, the form of a hill. The inner shores of the island, exposed to the surf, consist of fine sand, which is washed up by the tide. Between the small islands under their protection, and even in the middle of the inner sea, are found smaller pieces of coral, which seek a quiet abode, form in time, though very slowly, banks, till they at last reach the surface of the water; gradually increase in extent; unite with the islands that surround them; and at length fill up the minor seas, so that what was at first a ring of islands, becomes one connected land. The islands which are so far formed, retain in the middle a flat plain, which is always lower than the wall that surrounds them on the banks; for which reason pools of water are formed in them, after a continued rain,—the only springs and wells they possess. One of the peculiarities of these islands is, that no dew falls in the evening, that they cause no tempests, and do not check the course of the wind. The very low situation of the country sometimes exposes the inhabitants to great danger, and threatens their lives when the waves roll over their islands, if it happens that the equinox and full moon fall on the same day (consequently when the water has reached its greatest height), and a storm agitates the sea at the same time. These islands are said to be also shaken by earthquakes.

MM. Quoy and Gaimard, in a lately published memoir, propose, 1*st*, To examine how corals raise their habitations upon rocks, and what circumstances are favourable or unfavourable to their growth. 2*d*, To shew that there are no islands of any extent, constantly inhabited by man, which are entirely formed of corals; and that far from raising from the depths of the ocean perpendicular walls, as has been alleged, these animals form only layers or crusts of a few fathoms thickness.

The following, according to the French naturalists, is the manner in which this addition or superposition of madrepores is effected. In the places where the heat is constantly intense, where the land is indented by bays containing shallow and quiet water, which is not liable to be agitated by great surges, or by the regular breezes of the tropics, there also the saxigenous polypi multiply. They construct their habitations on the submarine rocks, envelope these rocks in whole or in part, but do not form them properly speaking. Thus, all those reefs, those girdles of madrepore, which are so frequently met with in the South Sea, to the leeward of islands, are shoals depending upon the conformation of the original ground, which will be perceived to belong to it when the direction of the mountains and hills has been attentively observed. It is always where the slopes are gentle, and the sea shallowest, that the greatest masses of madrepores are found. They sprout up if it is calm; in the contrary case, they form only scattered tufts, belonging to species which seem to be least affected by the agitation of the waters.

It has been said, and it is even a matter of general belief among mariners, say MM. Quoy and Gaimard, that there occur in the equatorial seas shoals composed of *corals*, which rise from the greatest depths, like walls at the bottom of which the sounding line finds no ground. The fact certainly does exist in so far as regards the depth spoken of; and it is this very circumstance which is productive of so much danger to vessels, which, when taken in a calm and carried away by currents, cannot cast anchor in such places. But it is not correct to say that these reefs are entirely formed of madrepores. First, because the species which always form the most considerable banks, such as some meandrinæ, certain caryophylleæ, but especially the astreæ, adorned with the most beautiful and velvety colours, require the influence of light to perfect them; because they are not seen to grow beyond a few yards of depth; and because they cannot consequently be developed at a depth of ten or twelve hundred feet, as they would necessarily be, did they raise the cliffs in question. Besides, these different species of animals would then almost exclusively enjoy the privilege of living at all depths, under all degrees of pressure, and, so to speak, in all temperatures.

Another circumstance to which navigators have not adverted, which corroborates the opinion here stated, is, that, in depths so great as those to which we allude, the sea, always agitated at the surface, breaks with force upon these reefs, without requiring for that purpose any additional impulse from the winds. And by merely attending to the necessary consequences of the observations of these same navigators, who say (what is very true) that, wherever the waves are agitated, the lithophytes are unable to go on with their work, because they destroy their frail edifices, we shall acquire the moral certainty that these submarine steeps are not produced by these animalcules. But, in these same places, let there occur a hollow, a sheltered spot of some kind, and then they will immediately raise their habitations, and will contribute to diminish the little depth that already exists there. And this is what may be seen in almost all the places where an elevated temperature permits these animals to grow in abundance.

In the localities where the tides are sensible, their currents alone may sometimes form irregular canals between the madrepores, without their ever being encumbered with their species, from the twofold cause united, of the motion and the coldness of the water; while, on the other hand, the flexible alcyonia are seen to multiply there.

When these geological dispositions are carefully observed, we see that the zoophytes rise to the surface of the waves, never beyond it; after which the generation which has attained thus far appears to die. It is destroyed much sooner, if, from the effect of the tides, these frail animalcules are exposed naked to the action of a burning sun. When there occur small hollows in these heaps of inert spoils, deprived of their inhabitants, which are always covered by the water, several tufts of those lithophytes are still remarked, which, having escaped from the almost general destruction, glow with the most lively colours. Then, the families which are developed anew, not being able to build on the outside of those reefs on which the sea is constantly breaking, draw nearer and nearer the shore, where the waves now deadened have scarcely any more action upon them, as in the Isle of France, at Timor, the Papua, the Marian, and the Sandwich Islands; provided always the waters had not a great depth, as is the case at Turtle Island, of which Cook speaks, where no bottom is found between the madrepore reefs and the island, notwithstanding the shortness of the space which exists between these two points.

If we examine these animals in the places best adapted to their growth, we shall see their different species, the forms of which, as varied as they are elegant, become rounded into balls, spread out into fans, or ramify into trees, mingling together, blending with each other, and reflecting the varied hues of red, yellow, blue and violet.

It is well known that all these alleged walls, exclusively formed of corals, are intersected with openings through which the sea enters and retires with violence; and every body knows the danger which Captain Cook ran on one occasion, on the coast of New Holland, when he had no other resource, in order to save himself from destruction, than to take the sudden resolution of attempting one of these narrow passes, where one is always sure of finding plenty of water. And this circumstance also comes in support of what we have advanced; for, if these perpendicular walls were entirely composed of madrepores, they would present no deep openings in their continuity, because it is the property of zoophytes to build in masses that have no interruption; and because, again, could they raise themselves from very great depths, they would end with encumbering and shutting up these passages; a circumstance which does not take place, and probably never will, from the causes which we have related.

If these facts prove, that madrepores cannot exist at very great depths, the submarine rocks, which they only increase in height, are not, therefore, exclusively formed by them.

We now come to the second part of the argument; and we assert, that there are no islands of any magnitude and constantly inhabited by man, that are formed by corals; and that the layers which they construct under the water, are not more than a few fathoms in thickness.

We shall commence with the second part of this question. The impossibility of penetrating to the bottom of the sea to examine at what precise depth the solid zoophytes establish themselves, constrains us to confine ourselves to what has taken place in former times; and the monuments which the ancient revolutions of the globe have disclosed to our view, will serve to prove what is going on in our own days. We shall mention what has been seen in several places, and we shall first speak of the island which Peron took for the theatre of the great works of these polypi, namely the island of Timor.

The banks of coral which the sea has left exposed in the land, as it retired, are remarkable for their uncommon magnitude. The whole shores of Coupang are formed of them, and the low hills in its vicinity are enveloped in them; but a few hundred yards from the town, they disappear, when distinct strata of slate make their appearance. The corals form a bed over the subjacent rocks from 25 to 80 feet thick.

Every thing announces that, in the Island of Timor, there exist no mountains exclusively formed of corals. As in all extensive countries, they are composed of various substances. Quoy and Gaimard having coasted it for about fifty leagues, sufficiently near to enable them to form an idea of its geography, were able to see that it exhibited volcanic appearances in several parts. Besides it abounds in mines of gold and copper, which, in conjunction with what we have already mentioned, shews in a general way the nature of the rocks of which it is composed.

Perhaps, remarks Quoy and Gaimard, the Bald-Head, a mountain of King George's harbour in New Holland, which Vancouver has described in passing, and on the summit of which he saw perfectly preserved branches of coral, might be adduced as a fact in opposition to the opinion here advanced. Yet the phenomenon exhibited there, is still precisely the same as at Timor, and in a thousand other places *. The zoophytes have built upon a basis previously existing, and they occupy only the surface of

---

* A remarkable fact of this kind is related by Salt, in his second journey to Abyssinia. The Bay of Amphila, in the Red Sea, is formed, he says, of twelve islands, eleven of which are in part composed of alluvial matters, consisting of corallines, madrepores, echinites, and a great variety of shells common in that sea. The height of these islands is sometimes thirty feet above high water. The small island, which dif-

it. For why should this Bald-Head differ from Mount Gardner, which, although close by it, is formed of primitive rocks? Besides, Peron says, that it has the same geological constitution. (T. ii. p. 133.)

At Rota, one of the Marian Isles, M. Gaudichaud, detached from the limestone rock, at about a hundred toises [above the level of the sea, branches of true madrepores, in perfect preservation. Here are, then, three localities in which they are found at great heights. We have observed them, say the French naturalists, at infinitely lower elevations in several other places, as at the Isle of France, where they form a bed more than six feet thick, between two streams of lava; at Wahou, one of the Sandwich Islands, where they have not a greater elevation, but extend for several hundred toises over the surface of the island. In all these cases, it is necessary to distinguish between the lithophytes, which have, by their living powers, formed continuous masses, from those which, after having been rolled about, broken down by the water, and mixed with sea shells, contribute to form those deposits known by the name of *madrepore limestone*. The latter sort is nothing but the debris of the former. Deposits of this description occur in the Marian Isles, and in those of the Papous; they occur also on the coasts of France, and in several other places.

It would appear from observations made in Timor and other places, that the species of the genus Astræa which

---

fers from the eleven others, is composed of a solid limestone rock, in which veins of calcedony are observed. Does not this small island, we may ask, indicate that some cause has prevented the madrepores from covering it, while they constructed their habitations in the neighbourhood, on bases which probably must be of the same nature as those of the small island?

are the only ones capable of covering immense extents of surface, do not commence their operations at a greater depth than twenty-five or thirty feet, in order to raise their habitations to near the surface of the sea. Fragments of these species are never obtained, either with the sounding line, or upon the anchors; nor do we ever see them, unless in places where the water is shallow; while the branched madrepores, which do not form thick and continuous beds, either on the elevated places which the ocean has left, or on the shores where they still exist, live at considerable depths.

It is evident, then, that these corals have erected their fabrics on the summits of submarine hills and mountains; and that all those reefs of Taiti, the Dangerous Archipelago, Navigators' Islands, the Friendly Islands, &c. are composed of madrepores only at the surface.

We thus consider it demonstrated, that the rocks of the solid zoophytes or coral, are not capable of forming the immense bases on which the greater number of the islands that occur in the Pacific Ocean rest.

There now remains for us to state how these animals, by their union, are capable of raising small islets. Forster, as already stated, has given a very good description of the manner in which this is effected. In fact, when these animalcules have raised their habitations to the surface of the water, under the shelter of the land, and they remain uncovered during the reflux of the tide, the hurricanes which sometimes supervene, by the agitation which they produce in those shallow waters, throw up from the bottom sand and mud. These substances are detained in the sinuosities and cavities formed between the corals, and thus serve to fix them together, and connect them into masses. Whenever the summit of this new island can remain constantly uncovered by the sea, and the waves can no longer destroy what they themselves have contributed to form, then its extent is enlarged, and its edges are gradually raised by the successive addition of sand. According to the direction of the winds and currents they may long remain sterile; but if the seeds of vegetables be transported to them from the neighbouring shores, by the action of these two causes, then, in latitudes favourable to their development, we presently see these islands becoming covered with verdure, the successively accumulated remains of which form layers of soil, which contribute to the elevation of the surface.

But, in order that this phenomenon of growth be accomplished, the distance from land must not be too great, because then the vegetables cannot get so easily to the islets in question, which then remain almost always bare and sterile. And for this reason what navigators report of those madrepore Islands of the Great Ocean, which are covered with verdure, and are yet at a great distance from any known land, has always appeared to us extraordinary; and that so much the more, that, in those vast spaces, the violence of the waves, which nothing can break there, must disturb the operations of the zoophytes. We do not, however, deny the existence of these islands, which it would be interesting carefully to examine anew; for, whenever navigators meet with low islands between the Tropics, they do not hesitate, in compliance with the generally received opinion, to say that they consist of madrepores. Yet how many islands, which scarcely rise above the surface of the water, recognise no such origin? We may mention, as an example, the Island of Boni, siuated under the equator, the beautiful vegetation of hich rises upon limestone. Cocoa Island, near Guam, in the same condition, being also composed of lime- one. In general, if they are inhabited, consequently ey have springs or lakes of fresh water, we may almost e certain that they are not composed of lithophytes, or re only so in part, because springs could not be formed n their porous substances. Some of the Caroline Isles re excessively low; we supposed them encrusted with nadrepores; and as they have inhabitants there must be omewhere in them a soil favourable to the accumulaion of fresh water *.

In restraining the power of these animalcules, concludes Quoy and Gaimard, and in pointing out the limits rhich nature has prescribed them, we have no other obect than to furnish more correct data to the naturalists rho aspire to great hypothetical considerations, regardng the conformation of the globe. On reconsidering hese zoophytes with greater attention, they will no longer e seen filling up the basins of the seas, raising islands, ncreasing the size of the continents, threatening future enerations with a solid equatorial circle formed of their poils. Their influence, with regard to the road-steads r harbours, in which they multiply, is already great nough, without adding more to it. But, compared with

---

* On glancing over the charts of Kotzebue's voyage, we are struck t seeing several of these islands grouped in a circular form, connected rith one another by reefs which appear to consist of madrepores, and o present, by this arrangement, a small internal sea of great depth, to rhich an entrance is afforded by one or more openings. May not this rrangement be owing to submarine craters, on the edge of which the ithophytes have erected their habitations?

the masses on which they rest, what are their layers, often interrupted, and which must be searched for with care, before they can be recognised, to the enormous volcanic peaks of the Sandwich Islands, the Island of Bourbon, the Moluccas, the Marian Islands, the mountains of Timor, New Guinea, &c. &c.? Nothing, certainly; and the solid zoophytes are in no degree capable of being compared with the testaceous mollusca, with reference to the materials which they have furnished, and still continue to furnish to the crust of the Globe.

NOTE I, p. 33.

ON THE LEVEL OF THE BALTIC.

About the middle of the last century, a controversy took place among the natural philosophers of the north of Europe, regarding the alleged gradual lowering of the level of the sea in general, and of the Baltic Sea in particular. Celsius was the first who introduced this idea to notice. He generalised it by applying it to all the planets, and was supported by the authority of the celebrated Linnæus. He soon perceived, however, that the point could never be settled by mere discussion, and that facts alone could lead to any certain result. Observation was therefore had recourse to; and thus the dispute in question had at least one good effect, that of directing to the subject the attention of men of science, whose situation might enable them to mark the variations of level that take place along the coasts of the

North Sea. The results of investigations undertaken for this purpose, are now beginning to be collected.

In the course of 1820 and 1821, Mr Bruncrona, assisted by the officers of the Pilotage Establishment, and other qualified persons, undertook the examination of all the authentic measures that had been established upon the west coast of the Baltic, during the last half century. The results of this examination are given in a short memoir, inserted in the Swedish Transactions for 1823. The following table indicates the degree to which the level of the sea has fallen during the last forty years, on the coast of Sweden, at various latitudes. It is proper to remark, that, in some of the places observed, the measures were much older, and in some others much more recent, than the period of forty years. In both these cases, the change of level that must have been effected during this period, has been estimated, by calculating the mean annual depression furnished by the observations.

Latitude.	Fall of surface in forty years.	Latitude.	Fall of surface in forty years.	Latitude.	Fall of surface in forty years.
East Coast.	Feet.	East Coast.	Feet.	East Coast.	Feet.
63° 59′	1.50	59° 17′	2.17	56° 10′	0.00
... ...	2.50	58 44	1.00	56 11	0.00
... ...	0.50	58 42	1.08	55 53	0.00
61 43	2.50	58 45	1.17		
61 37	2.83	58 35	2.00	South-West Coast.	
61 32	2.50	58 28	0.07	55 23	0.00
61 45	2.50	58 11	0.83	55 22	0.00
60 11	2.33	58 8	1.00	57 21	0.00
59 46	0.17	57 50	1.00	57 53	1.00
59 46	2.00	56 41	0.41		

Of the facts collected in the course of this investigation, the following may be mentioned as tending to support the opinion of a fall of level.

1*st*, It is generally believed among the pilots of the Baltic, that the sea has become shallower along the course which vessels ordinarily follow ; but, it is added, that this alteration is more sensible in the places where the tide collects sand, detached pebbles, and sea-weeds, or in those where the bottom is composed of rocks. The same observation has been made in the neighbourhood of some large towns and fisheries ; for example, a hydrographic chart made in 1771, gives six fathoms for the mean depth of the sea opposite the harbour of Landskrona, whereas, in 1817, the sounding line scarcely gave five fathoms at the same point.

2*d*, According to the oldest and most experienced pilots, the straits which separate the numerous islets scattered along the coast of Sweden, from Haarparanda to the frontiers of Norway, received vessels that drew ten feet of water ; now they are not practicable for boats that draw more than two or three feet.

3*d*, The pilots further affirm, that, along the whole coast of Bahusia, the bottom undergoes a diminution, which becomes sensible every ten years in certain places, where it is composed of rocks. Several other parts of the Baltic may be cited, in which a similar change has been remarked.

M. C. P. Hallstrom, in an Appendix to Mr Bruncrona's Memoir, gives the following table of the diminution observed in the depth of the waters of the Gulf of Bothnia.

PLACES.	Mean marked in	Height of the water reobserved in	Fall beneath the original mark in feet.	Number of years.	Fall of the water in 100 years, in feet.
, parish of Lower Kalix,	1770	1750	2.05	50	4.10
		1775	2.49	75	4.32
ben, parish of Pitea,	1751	1785	1.70	34	5.00
		1796	1.90	45	4.22
arish of Bygdea,	1749	1785	2.70	36	4.72
		1795	2.50	46	5.43
		1819	2.60	70	3.47
	1774	1785	0.55	11	5.00
		1795	1.16	21	5.52
		1819	1.60	45	3.57
	1795	1819	0.65	24	2.71
t, on the coast of Wasa,	1755	1797	1.70	42	4.05
		1821	2.87	65	4.35
on the coast of Wasa,	1755	1785	1.45	30	4.83
		1797	1.69	42	4.02
		1821	2.87	65	4.35
det, near Sefle,	1731	1785	2.90	54	5.37
		1796	2.17	65	3.34
Angermanland,	1795	1822	1.58	27	5.85

not demonstrated that the numbers of the last
present exactly the lowering of the water in a
for it has not yet been sufficiently determined
wering be uniform, or if it vary at different pe-
l if it depend upon some local circumstance,—
climate,—or upon the state of the atmosphere.
properly established, that this lowering, which
less perceptible from the north of the Baltic, un-
ppears entirely at the southern extremity, fol-
cisely the same law of diminution as the lati-
t appears to be uniform in the whole extent of
of Bothnia, and it rises about four feet and a
n that region; at Calmar (lat. 57° 50′) it is on-

ly two feet; but it is not yet known whether it decreases in a regular manner between these two places.

Some authors consider the facts related by MM. Bruncrona and Halstrom, as deciding the question in favour of those who believe in a lowering of the level of the Baltic. The editor of the *Annalen der Physik* * goes farther, and seems to consider it as confirming the opinion of a general lowering of the level of the sea. In support of this opinion, he adduces the traditions and observations of the natives of Otaheite and of the Moluccas and Sunda Islands, regarding the retreat of the sea in several parts of their coast. We are disposed to stand neutral in this matter. The geographers who have collected the greatest number of facts relating to the level of the inland seas, and of the ocean in its various regions, find nearly as many in favour of a rise as in favour of a fall of level. The very distribution of contrary indications, leads them to believe in a partial displacement of the mass of waters from one region towards another, and even from the one side of an inland sea towards the opposite side; a displacement which might be owing to fugitive or more or less durable causes, such as a variation of temperature in the polar regions, the action of winds and of currents, modified by the greater or less quantity of water in the rivers that feed the different basins, upon the sides opposed to their direction.

---

* 1824, St. 12. p. 443.

Malté Brun. Precis de la Geogr. Univers. T. ii. p. 459.; Catteau Calleville, Tabl. de la Mer Balt. T. i. p. 158, 188.

Are the facts contained in the memoir in question of a nature to overthrow this opinion? They do not appear so to us. The two series of observations which are adduced, only shew a fall upon the coasts of Sweden, properly so called, that is to say, upon the west coast of the Baltic, and the east coast of the Cattegat. Two observations only have been made upon the coasts of Finland, toward the extremity of the Gulf of Bothnia. These facts would perfectly accord with the opinion of those who think that the currents determined from the north to the south of the Baltic by the numerous streams which rush into it, push the waters toward the south shore, that of Pomerania, Mecklenbourg, and Holstein; and that the waters consequently gain upon the land on this coast, as numerous historical facts attest, while they retire along the northern shores, those of the Gulf of Bothnia. Be this as it may, the question as to the constancy of the level of the sea cannot be considered as decided, until a long series of observations shall have been made upon authentic and perfectly fixed measures erected upon all the shores of the different seas, and of the different regions of the ocean. Those which have been published in the Swedish Transactions furnish important documents for this purpose; and similar ones should be begun to be collected in other countries.

The phenomena exhibited by the waters of the Baltic engaged the attention of two rival speculators, Playfair and Deluc; and their views are often alluded to by geologists. We shall here state them in their own words. Professor Playfair, in his well known and elegant work on the Huttonian Theory of the Earth, has the following remarks:

"If we proceed further to the north, to the shores of the *Baltic* for instance, we have undoubted evidence of a *change of level* in the same direction as on our own shores. The level of the sea has been represented as lowering at so great a rate as *forty inches in a century*. Celsius observed, that several rocks which are now above the water, were not long ago sunken rocks, and dangerous to navigators; and he took particular notice of one which, in the year 1680, was on the surface of the water, and, in the year 1731, was 20½ Swedish inches above it. From an inscription near *Aspo*, in the lake *Melar*, which communicates with the *Baltic*, engraved, as is supposed, about five centuries ago, the level of the sea appears to have sunk in that time no less than thirteen Swedish feet. All these facts, with many more which it is unnecessary to enumerate, make the *gradual depression*, not only of the *Baltic*, but of the whole *Northern Ocean*, a matter of certainty."—*Playfair's Illustrations*, p. 445.

That indefatigable and accurate observer De Luc, has the following commentary on the preceding passage:

"It would be unnecessary to mention even the two inconsiderable facts above, if the *depression* of the *level* of the seas were indeed a matter of certainty; for the best authenticated and the least equivocal monuments of their change would then abound along all their coasts. But proofs are every where found that such a change is chimerical: they may be seen in all the vales coming down to these seas, in which there is no perceptible impression of the action of any waters but those of the land, and no vestige, through their whole extent, of any permanent abode of those of the sea; and proofs to the same effect are equally visible, along the coasts of both these seas, in all the new lands which have been formed on them, and which, being perfectly horizontal from the point where their formation commenced, evidently show that the water displaced by them has been constantly at the same level. Hence appears the necessity of multiplying, as I have done, and shall continue to do, for the subversion of a prejudice of such ancient date, the examples of these peremptory proofs of its total want of foundation. The rock mentioned by Celsius had probably been observed by him at times when the level of the sea was different; its known differences much exceeding the quantity here specified. As for the inscription near Aspo, in a country abounding with lakes as much as that which I have above described, if we are acquainted with its terms, we should probably find it to be, like many which I have seen in various places along the course of the Oder and the Elbe, the monument of some extraordinary inundation of the land, from the sudden melting of the snows in the mountains, at a time when the water had been prevented from running off by an equally extraordinary rise of the level of the sea; of which the effects on low coasts may extend very far inland.

"By this conclusion, however, from these few facts, contrary to every thing observed on the coasts of this sea, Mr Playfair thinks himself authorised to maintain, that the gradual depression, not only of the Baltic, but of the whole northern ocean, is a matter of certainty; afterwards he examines merely which of these two causes, the subsidence of the sea itself, or the elevation of the land around it, agrees the best with the phenomena; and he decides in favour of the latter, pointing out its accordance with the Huttonian Theory."

NOTE L, p. 119.

FOSSIL REMAINS OF THE HUMAN SPECIES.

FROM the observations of Werner and others, it appears, that the most simple animals are those first met with in a mineralized state; that these are succeeded by others more perfect, and which are contained in newer formations; and that the most perfect, as quadrupeds, occur only in the newest formation. But we naturally inquire, have no remains of the human species been hitherto discovered in any of the formations? Judging from the arrangement already mentioned, we would naturally expect to meet with remains of man in the newest of the formations. In the writings of ancient authors there are descriptions of anthropolithi. In the year 1577, Fel. Plater, Professor of Anatomy at Basle, described several fossil bones of the elephant found at Lucerne, as those of a giant at least nineteen feet high. The Lucernese were so perfectly satisfied with this discovery, that they caused a painting to be made of the giant, as he must have appeared when alive, assumed two such giants as the supporters of the city arms, and had the painting hung in their public hall. The Landvoigt Engel, not satisfied with this account of these remains, maintained that our planet, before the creation of the present race of men, was inhabited by fallen angels, and that these bones were part of the skeletons of some of those miserable beings. Scheuchzer published an engraving and description of a fossil human skeleton, which proved to be a gigantic species of salamander or proteus.

Spallanzani describes a hill of fossil human bones in the island of Cerigo; but this also is an error, as has been satisfactorily shewn by Blumenbach. Lately, however, a fossil human skeleton has been imported into this country from Guadaloupe, by Sir Alexander Cochrane. It is imbedded in a block of calcareous stone, composed of particles of limestone and coral, and which, like the aggregations of shells found on the limestone coasts in some parts of this country, has acquired a great degree of hardness. It is therefore an instance of a fossil human petrifaction in an alluvial formation. The engraving here given is copied from the Philosophical Transactions of the Royal Society of London; and the following description of the fossil remains it exhibits is that of Mr Konig, which has been drawn up with great care.

" The situation of the skeleton in the block was so superficial, that its presence in the rock on the coast had probably been indicated by the projection of some of the more elevated parts of the left fore-arm.

" The operation of laying the bones open to view, and of reducing the superfluous length of the block at its extremities, being performed with all the care which its excessive hardness, and the relative softness of the bones, required, the skeleton exhibited itself in the manner represented in the annexed drawing (Pl. I.) with which my friend Mr Alexander has been so good as to illustrate this description.

" The skull is wanting; a circumstance which is the more to be regretted, as this characteristic part might possibly have thrown some light on the subject under consideration, or would, at least, have settled the question, whether the skeleton is that of a Carib, who used to give the frontal bone of the head a particular shape by compression, which had the effect of depressing the upper and protruding the lower edge of the orbits, so as to make the direction of their opening nearly upwards, or horizontal, instead of vertical [*].

"The vertebræ of the neck were lost with the head. The bones of the thorax bear all the marks of considerable concussion, and are completely dislocated. The seven true ribs of the left side, though their heads are not in connexion with the vertebræ, are complete; but only three of the false ribs are observable. On the right side only fragments of these bones are seen; but the upper part of the seven true ribs of this side are found on the left, and might at first sight be taken for the termination of the left ribs; as may be seen in the drawing. The right ribs must therefore have been violently broken and carried over to the left side, where, if this mode of viewing the subject be correct, the sternum must likewise lie concealed below the termination of the ribs. The small bone dependent above the upper ribs of the left side, appears to be the right clavicle. The right os humeri is lost; of the left nothing remains except the condyles in connexion with the fore-arm, which is in the state of pronation; the radius of this side exists nearly in its full length, while of the ulna the lower part only remains, which is considerably pushed upwards. Of the two bones of the right fore-arm, the inferior terminations are seen. Both the rows of the bones of the wrists are lost, but the whole metacarpus of the left hand is displayed, together with part of the bones of the fingers:

---

[*] See the excellent figures in Blumenbach's Decades.

the first joint of the fore-finger rests on the upper ridge of the os pubis; the two others, detached from their metacarpal bones, are propelled downwards, and situated at the inner side of the femur, and below the foramen magnum ischii of this side. Vestiges of three of the fingers of the right hand are likewise visible, considerably below the lower portion of the fore-arm, and close to the upper extremity of the femur. The vertebræ may be traced along the whole length of the column, but are in no part of it well defined. Of the os sacrum, the superior portion only is distinct: it is disunited from the last vertebra and the ilium, and driven upwards. The left os ilium is nearly complete, but shattered, and one of the fragments depressed below the level of the rest; the ossa pubis, though well defined, are gradually lost in the mass of the stone. On the right side, the os innominatum is completely shattered, and the fragments are sunk: but towards the acetabulum, part of its internal cellular structure is discernible.

" The thigh-bones, and the bones of the leg of the right side, are in good preservation, but being considerably turned outwards, the fibula lies buried in the stone, and is not seen. The lower part of the femur of this side is indicated only by a bony outline, and appears to have been distended by the compact limestone that fills the cavities both of the bones of the leg and thigh, and to the expansion of which, these bones probably owe their present shattered condition. The lower end of the left thigh-bone appears to have been broken and lost in the operation of detaching the block; the two bones of the leg, however, on this side, are nearly complete; the tibia was split almost the whole of its length a little below the external edge, and the fissure being filled up with limestone, now presents itself as a dark-coloured straight line. The portion of the stone which contained part of the bones of the tarsus and metatarsus, was unfortunately broken; but the separate fragments are preserved.

"The whole of the bones, when first laid bare, had a mouldering appearance, and the hard surrounding stone could not be detached without frequently injuring their surface; but after an exposure for some days to the air, they acquired a considerable degree of hardness. Sir H. Davy, who subjected a small portion of them to chemical analysis, found that they contained part of their animal matter, and all their phosphate of lime."

NOTE M, p. 128.

Account of the Displacement of that part of the Coast of the Adriatic which is occupied by the Mouths of the Po.

THAT portion of the shore of the Adriatic which lies between the lake, or rather *lagune*, of Commachio, and the *lagunes* of Venice, has undergone considerable alterations since ancient times, as is attested by authors worthy of entire credit, and as is still evinced by the actual state of the soil in the districts near the coast; but it is impossible now to give any exact detail of the successive progress of these changes, and more especially of their precise measures during the ages which preceded the twelfth century of our era.

We are, however, certain, that the city of *Hatria*, now called *Adria*, was formerly situated on the edge of the coast; and by this we attain a known fixed point upon the primitive shore, whence the nearest part of the present coast, at the mouth of the Adige, is at the distance of [illegible],000 metres[*]; and it will be seen in the sequel, that the extreme point of the alluvial promontory formed by the Po, is farther advanced into the sea than the mouth of the Adige by nearly 10,000 metres[†].

The inhabitants of Adria have formed exaggerated pretensions, in many respects, as to the high antiquity of their city, though it is undeniably one of the most ancient in Italy, as it gave name to the sea which once washed its walls. By some researches made in its interior and its environs, a stratum of earth has been found mixed with fragments of Etruscan pottery, and with nothing whatever of Roman manufacture. Etruscan and Roman pottery are found mixed together in a superior bed, on the top of which the vestiges of a theatre have been discovered. Both of these beds are far below the level of the present soil. I have seen at Adria very curious collections, in which these remains of antiquity are separately classed; and having, some years ago, observed to the viceroy, that it would be of great importance, both low the external edge, and the fissure being filled up with limestone, now presents itself as a dark-coloured straight line. The portion of the stone which contained part of the bones of the tarsus and metatarsus, was unfortunately broken; but the separate fragments are preserved.

---

[*] Equal to 27,340 yards and 10 inches English measure, or 15½ miles and 60 yards.

In these reductions of the revolutionary French *metres* to English measure, the *metre* is assumed as 39,37 English inches.—*Transl.*

[†] Or 10,936 yards and 4 inches, equal to 6 miles and nearly a quarter, English measure.

Hence the entire advance of the alluvial promontory of the Po appears to have extended to 21 miles 5 furlongs and 216 yards.—*Transl.*

"The whole of the bones, when first laid bare, had a mouldering appearance, and the hard surrounding stone could not be detached without frequently injuring their surface; but after an exposure for some days to the air, they acquired a considerable degree of hardness. Sir H. Davy, who subjected a small portion of them to chemical analysis, found that they contained part of their animal matter, and all their phosphate of lime."

NOTE M, p. 128.

Account of the Displacement of that part of the Coast of the Adriatic which is occupied by the Mouths of the Po.

THAT portion of the shore of the Adriatic which lies between the lake, or rather *lagune*, of Commachio, and the *lagunes* of Venice, has undergone considerable alterations since ancient times, as is attested by authors worthy of entire credit, and as is still evinced by the actual state of the soil in the districts near the coast; but it is impossible now to give any exact detail of the successive progress of these changes, and more especially of their precise measures during the ages which preceded the twelfth century of our era.

We are, however, certain, that the city of *Hatria*, now called *Adria*, was formerly situated on the edge of the coast; and by this we attain a known fixed point upon the primitive shore, whence the nearest part of the present coast, at the mouth of the Adige, is at the distance of 25,000 *metres* [*]; and it will be seen in the sequel, that the extreme point of the alluvial promontory formed by the Po, is farther advanced into the sea than the mouth of the Adige by nearly 10,000 metres [†].

The inhabitants of Adria have formed exaggerated pretensions, in many respects, as to the high antiquity of their city, though it is undeniably one of the most ancient in Italy, as it gave name to the sea which once washed its walls. By some researches made in its interior and its environs, a stratum of earth has been found mixed with fragments of Etruscan pottery, and with nothing whatever of Roman manufacture. Etruscan and Roman pottery are found mixed together in a superior bed, on the top of which the vestiges of a theatre have been discovered. Both of these beds are far below the level of the present soil. I have seen at Adria very curious collections, in which these remains of antiquity are separately classed; and having, some years ago, observed to the viceroy, that it would be of great importance, both to history and geology, to make a thorough search into these buried remains at Adria, carefully noticing the levels in comparison with the sea, both of the primitive soil, and of the successive alluvial beds, his Highness entered warmly into my ideas; but I know not whether these propositions have been since carried into effect.

---

[*] Equal to 27,340 yards and 10 inches English measure, or 15½ miles and 60 yards.

In these reductions of the revolutionary French *metres* to English measure, the *metre* is assumed as 39,37 English inches.—*Transl.*

[†] Or 10,936 yards and 4 inches, equal to 6 miles and nearly a quarter, English measure.

Hence the entire advance of the alluvial promontory of the Po appears to have extended to 21 miles 5 furlongs and 216 yards.—*Transl.*

Following the coast, after leaving Hatria, which was situated at the bottom of a small bay or gulf, we find to the south a branch of the *Athesis* or Adige, and of the *Fossa Philistina*, of which the remaining trace corresponds to what might have been the Mincio and Tartaro united, if the Po had still run to the south of Ferrara. We next find the *Delta Venetum*, which seems to have occupied the place where the lake or lagune of Commachio is now situated. This delta was traversed by seven branches of the *Eridanus* or Po, formerly called also the *Vadis Padus* or *Podincus;* which river, at the diramification of these seven branches, and upon its left or northern bank, had a city named *Trigoboli*, whose site could not be far from where Ferrara now stands. Seven lakes, inclosed within this delta, were called *Septem Maria*, and Hatria was sometimes denominated *Urbs Septem Marium*, or the city of the seven seas or lakes.

Following the coast from Hatria to the northwards, we come to the principal mouth of the *Athesis* or Adige, formerly named *Fossa Philistina*, and afterwards *Estuarium Altini*, an interior sea, separated by a range of small islands from the Adriatic Gulf, in the middle of which was a cluster of other small isles, called *Rialtum*, and upon this archipelago the city of Venice is now seated. The *Estuarium Altini* is what is now called the Lagune of Venice, and no longer communicates with the sea, except by five passages, the small islands of the Archipelago having been united into a continuous dike.

To the east of the lagunes, and north from the city of Este, we find the *Euganian* mountains, or hills, forming, in the midst of a vast alluvial plain, a remarkable isolated group of rounded hills, near which spot the fable of the ancients supposes the fall of Phæton to have taken place. Some writers have supposed that this fable may have originated from the fall of some vast masses of inflamed matters near the mouths of the Eridanus, that had been thrown up by a volcanic explosion; and it is certain that abundance of volcanic products are found in the neighbourhood of Padua and Verona.

The most ancient notices that I have been able to procure respecting the situation of the shores of the Adriatic at the mouths of the Po, only begin to be precise in the twelfth century. At that epoch the whole waters of this river flowed to the south of Ferrara, in the *Po de Volano* and the *Po di Primaro*, branches which inclosed the space occupied by the *lagune* of Commachio. The two branches which were next formed by an irruption of the waters of the Po to the north of Ferraro, were named the river of *Corbola*, *Longola*, or *Mazzorno*, and the river *Toi*. The former, and more northern of these, received the *Tartaro*, or *canal bianco*, near the sea, and the latter was joined at Ariano by another branch derived from the Po, called the *Goro river*. The sea-coast was evidently directed from south to north, at the distance of ten or eleven thousand *metres** from the meridian of Adria; and *Loreo*, to the north of *Mesola*, was only about 2000 *metres*† from the coast.

---

* Equal to 10,936 or 12,030 yards English measure.—*Transl.*

† Or 2,186 yards 2 feet English.—*Transl.*

Towards the middle of the twelfth century, the flood-waters of the Po were retained on their left or northern side by dikes near the small city of *Ficarolo*, which is about 19,000 *metres*[*] to the north-west of Ferrara, spreading themselves southwards over the northern part of the territory of Ferrara and the *Polesine* of Rovigo, and flowed through the two formerly mentioned canals of *Mazzorno* and *Toi*. It seems perfectly ascertained, that this change in the direction of the waters of the Po had been produced by the effects of human labours; and the historians who have recorded this remarkable fact only differ from each other in some of the more minute details. The tendency of the river to flow in the new channels, which had been opened for the more ready discharge of its waters when in flood, continually increased; owing to which the two ancient chief branches, the *Volano* and *Primaro*, rapidly decreased, and were reduced in less than a century to their present comparatively insignificant size; while the main direction of the river was established between the mouth of the Adige to the north, and what is now called *Porto di Goro*, on the south. The two before-mentioned canals of *Mazzorno* and *Toi* becoming insufficient for the discharge, others were dug; and the principal mouth, called *Bocco Tramontana*, or the northern mouth, having approached the mouth of the Adige, the Venetians became alarmed in 1604; when they excavated a new canal of discharge, named *Taglio de Porto Viro*, or *Po delle Fornaci*, by which means the *Bocco Maestra* was diverted from the Adige towards the south.

---

[*] Or 20,778 yards 1 foot 10 inches.—*Transl.*

Thirdly, That the extremities of the promontories formed by the two principal branches of the Po, before the excavation of the *Taglio di Porto Viro*, had extended, by the year 1600, or in four hundred years, to a medium distance of 18,500 *metres*[*] beyond Adria; giving, from the year 1200, an average yearly increase of the alluvial land of 25 *metres*[†].

Fourthly, That the extreme point of the present single promontory, formed by the alluvions of the existing branches, is advanced to between thirty-two and thirty-three thousand *metres*[‡] beyond Adria; whence the average yearly progress is about seventy *metres*[§] during the last two hundred years, being a greatly more rapid proportion than in former times.

PRONY.

NOTE, p. 244.

On the Universal Deluge.

MR CUVIER in the present work, and more recently in a note to Mr Lemaire's edition of Ovid's Metamorphoses, enumerates the Mosaic, Grecian, Assyrian, Persian, Indian, and Chinese traditions, concerning a universal deluge; and concludes from them, that the surface of the globe, five or six thousand years ago, underwent a general and sudden revolution, by which the lands inhabited by the human beings who lived at that time, and by the various species of animals known at the present day, were overflowed by the ocean; out of which emerged the present habitable portions of the globe. This celebrated naturalist maintains, that these regions of the earth were peopled by the few individuals who were preserved, and that the tradition of the catastrophe has been preserved among these new races of people, variously modified by the difference of their situation and their social disposition. According to Mr Cuvier. similar revolutions of nature had taken place, at periods long antecedent to that of the Mosaic deluge. The dry land was inhabited, if not by human beings, at least by land animals at an earlier period; and must have been changed from the dry land to the bed of the ocean; and it might even be concluded from the various species of animals contained in it, that this change, as well as its opposite, had occurred more than once.

---

[*] Or 20,231 yards.—*Transl.*

[†] Exactly 27 yards 1 foot and ¼th of an inch English.—*Transl.*

[‡] Already stated at from 19¾ to 20⅛ miles; or more precisely, from 34,995 yards 1 foot 8 inches, to 36,089 yards 10 inches English measure.—*Transl.*

[§] Equal to 76 yards 1 foot 7 inches and 9-10ths.—*Transl.*

This opinion being brought forward in a geognostic work, especially in a work abounding in such valuable matters of fact, and stated as the result of geognostic investigation, we may be permitted, in this point of view, to examine it; and to ask, whether, from the phenomena exhibited by the present condition of the earth's surface, we are entitled to conclude that it owes its conformation to such a universal deluge.

We know, from arguments suggested by chemistry and the higher mechanics, that the globe was once in a state of fluidity; hence it might be maintained with some appearance of probability, that the condition of the earth, previous to the existence of organic matter, depended upon fusion; and that the primitive rocks are of igneous origin. Since, however, granite has been found above rocks of various kinds which contain the remains of organic bodies, we are under no necessity of ascribing to primitive rocks an origin different from that of subsequent formations; and, without having recourse to other arguments, the fact, that aquatic animals are the most abundant of fossil organic remains from the earliest of the transition to the latest of the secondary and tertiary formations, affords evidence that they are precipitates from water.

Notwithstanding the great and daily advancement of science, our knowledge of chemistry is still too imperfect for us to arrive at an adequate knowledge of the state of this water, or rather sea, as, from its universal expansion, it must be denominated. Did it contain dissolved in it at the same time all the materials from which the various beds of rock were formed; what were the solvents of those materials which we find, either insoluble in water, or at least not easily soluble; by what means were the precipitates produced; and whence came this prodigious mass of waters? Upon these unanswered questions depend others no less important. The aquatic animals of a former world undoubtedly lived in this sea; otherwise, we must admit of another sea free from heterogeneous materials. But did these animals continue to live in it during the whole process of precipitation; and did this process proceed so slowly and imperceptibly, that animal life was not interrupted by it, and that only remains of dead animals, such as the skeletons of fishes, and the covering of shell-fishes, were enveloped in the precipitates? Or, did animal life continue only during the state of solution; and were the myriads of aquatic animals found in beds of rocks buried in them alive? Many naturalists appear to entertain the latter opinion, from observing the agonies of death depicted in the distorted position of fishes in copper-slate, or from deriving the bituminous properties of stink-stone, as well as of marl, from the decomposition of animal bodies, of which such numerous vestiges are extant in these beds? In this way a plausible explanation is given of the phenomena of a former world that has perished. How, then, do they explain the constant appearance of so many species, which have continued without interruption for such an infinite length of time? Have these species been propagated by individuals who accidentally escaped destruction: or, Does a new race continually spring up again? But laying aside the difficulty of this explanation, the violent destruction of so many races of animals, is scarcely consistent with the general order of the universe, according to which, we behold every animal occupying its proper element, and fulfilling its particular destiny. We, therefore, involuntarily revert to the opinion, that those creatures, whose remains are preserved in beds of rocks, have lived continually in the sea, out of which the rocks were precipitated, in the same manner as the analogous species now living in the sea become enveloped in deposits still taking place, although on a comparatively small scale.

What has just been said does not entitle us to admit that the various parts of the earth have been, from time to time, overflowed with water. Yet are there other appearances which completely indicate such a change, namely, beds of coal, and the fossil remains of land animals. The carbonisation of roots of trees in clefts of rocks, and of marsh plants in peat-bogs, which takes place, as it were, under our own immediate observation; the transitions of bituminous wood into pitch-coal, the frequent presence of vegetables partly converted into coal, in the neighbourhood of beds of coal, and which are more abundant the nearer they are to these beds; and, finally, the chemical nature of coal, which is similar to that of vegetables, go to prove the vegetable origin of the older and independent coal formation.

Though some fossil vegetables might derive their origin, by being floated to quarters more or less remote from their native soil, as we find to be the case in many islands of the South Sea, and on other shores; on the other hand, neither the breadth and extent of beds of coal, nor the erect position in which fossil trees and reed plants are not unfrequently found in their neighbourhood, coincide with such an explanation. The plants, from which these beds were formed, once stood and grew in the place where they were buried; and, from these remains, we infer that they were entirely land plants, tree-ferns, *Lycopodia*, and other cryptogamia. It also appears undeniable, that the land, being once dry, was, during a longer or shorter time, covered with luxuriant vegetation; that it was afterwards overflowed with water, and then became dry land again. But, was this overflow of water produced by a sudden, violent, and universal catastrophe, such as we consider the deluge? Many circumstances leave room for opposite conjecture. If it is probable that the older or black coal is of vegetable origin, the plants from which it has originated, must have suffered an incomparably greater change than those of more recent coal formations. Their composition and their texture, afford evidence of a long operation of the fluid in which the changes were produced; and their situation, proves that the substance of the plants, though not entirely dissolved, was yet much comminuted, and was kept floating and swimming, and then precipitated. How can we, in any other way, account for the layers of sandstone and slate-clay, with which coal regularly alternates, so that from one to sixty alternate beds have been enumerated? How can we explain the combination of mineral coal with slate-clay, or account for the appearance of bituminous shale, flinty slate, of iron-pyrites and iron-ore, in the midst of mineral coal itself? We do not, however, admit of a repeated uncovering and covering of the land with water, and of a renewal of vegetation for every particular bed of coal; far from it, for violent inundations exhibit very different phenomena. These formations, like pure mineral formations, bear the evident impress of a lengthened operation, and of gentle precipitations; and whoever still entertains doubts regarding this, may have them completely removed by the condition in which vegetable remains are frequently found in the coal formations, by the perfect preservation of the most delicately shaped fern leaves, by the upright position of stems, and by other appearances of a similar character. It is also an important objection against the universality of the cover of water, notwithstanding the wide extent of beds of coal, that they are sometimes accompanied with fossil remains of fresh-water shells, from which we are entitled to draw the conclusion, that they must have been deposited in inclosed basins of inland waters.

From the beds of coal found in various situations among *Alpine* limestone, as well as in other secondary formations, under similar circumstances, we are at liberty to maintain that they are not indebted for their origin to any universal and sudden revolution.

When we proceed to the second division of coal formations, to brown coal, or to *lignite*, the principal difference we discover is, that the change which the vegetables have undergone, having taken place at a time when the chemical power had lost much of its energy, was incomplete; and besides, we observe in the different brown coal formations the same repetition of single beds alternating with other beds of rocks, the mixture of different minerals, and not unfrequently of upright stems. Some appear to be derived from sea plants, and others from fresh-water plants; but the greater proportion from land plants. They, equally with the beds of black coal, give evidence of a new overflow of water, and the water plants themselves, which never thrive at a great depth, and which frequently appear under prodigious beds of rocks, must have experienced such a change. But that change was scarcely of the kind which we understand by a deluge, and the frequent repetition of deluges indicated, according to some, by the repeated beds of coal from the transition to the newest tertiary periods, is hardly credible. It may be maintained, with more certainty, of *brown coal* than of *black coal*, that they have been formed in land water, and hence in limited and isolated basins of water, since fresh-water animals are their constant attendants.

Although the beds of coal of our secondary formations appear to have originated in a similar way with other mineral formations, and not by violent catastrophes, it is otherwise with a part of those vegetable remains which are met with in alluvial land. Subterranean forests, whose circumference, in some instances, extends about 70 square leagues, partly in a state of good preservation, and partly more or less decomposed, afford satisfactory proof of deluges, and have undoubtedly been covered up with earth by a violent eruption of standing or running water. But these are local effects, similar to what take place in our own day, but on a larger scale.

There are abundant fossil remains of land animals, resembling those of water animals, found in such a state of preservation, that we cannot suppose them to have been brought hither from distant places, and by means of currents. Their appearing in beds of rocks, or generally in aqueous precipitates, proves that the soil they first inhabited, must have been dry land, afterwards overflowed with water.

The appearance of what are called fresh water shells, in alternate beds with marine animals, being sometimes observed in newer flœtz rocks in great abundance, seems to indicate a reiterated retreat and return of the sea. But however meritorious the labours of naturalists, through whom attention has been directed to the subject, may be in other respects, we are nevertheless disposed to entertain doubts concerning their conclusions. In our own seas and ponds upon the coasts, we observe the same testaceous animals growing equally well in salt water, and in water nearly fresh; and, again, fresh water animals living in salt water *. By artificial means the inhabitants of the sea may be changed into inhabitants of fresh water; as fresh-water animals are, in their turn, converted into marine animals, so that, to decide concerning the proper element of each individual species is often matter of difficulty. Therefore, other circumstances besides that of containing salt must be taken into account. The occasional plenty, scarcity, or absolute want of food; the soil being sometimes sandy, slimy, or rocky; the depth, extent, agitation or tranquillity of the water; and, finally, the quality of the air contained in it, may be as instrumental in determining the habitation of these animals, as the materials which the water holds in solution. An excellent observer has indeed very lately shewn in a treatise, which supports the idea of fresh-water formations, that we possess no unerring character for distinguishing sea shell-fish from those of fresh water; but admitted, notwithstanding the transition above stated, we can draw a line of distinction between them, we must not forget that this investigation is neither regarding sea shell-fish now existing, nor of our present waters. We indeed draw our conclusion, and not without reason, from similar conformation, similar modes of existence. But one of two things must be; either that the shell-fish, whose remains are found in beds of rocks, lived in the water out of which these beds were precipitated, or the water in which they lived, was dislodged by other water containing the

---

* In the salt lakes of Westphalia, we find Lymnæa and fresh water plants in abundance.

materials of the precipitations. In the first and more generally admitted case, the water was so different from the present water, whether salt or fresh, that we cannot infer from the inhabitants of the latter any thing concerning the inhabitants of the former; but we can confidently maintain, that a greater resemblance prevails between our sea and land water, than between either the one or the other, and that fluid which was inhabited by the shell-fish. In other respects, there remains no other difference between fresh and salt water formations, but that the bottom upon which the former is placed, once contained land water; a fact worthy of observation: but the notion of enclosed basins, and of isolated formations originating in them, the way in which fresh water formations are supposed to have taken place, remained a long time unsatisfactory. Finally, we may be permitted to ask, upon what grounds they considered themselves entitled to ascribe to the former sea the continual possession of a portion of salt, while the salt precipitates appear only at particular invervals, and after long interruptions? If the sea occasionally contained a great, and sometimes a very small, quantity of salt, it might equally be at times altogether without it. And yet it deserves to be remembered, that the beds of rock, to which the salt formations are most nearly related, contain no petrifactions. That, therefore, the so-called marine animals are wanting in those periods during which we have any direct evidence of the presence of salt water.

There is, however, a geognostic fact, which in preference to all others, has been cited in evidence of violent revolutions and deluges, that is, the appearance of conglomerates or of reproduced kinds of stone. Indeed, there might still be a wide field for investigation here, and more than one formation, which now passes for sandstone, might be acknowledged as an original and chemical production; without having occasion to go so far as Mr Gerhard does with greywacke, that is, to consider them as immediate precipitates from the atmosphere. But still conglomerates sufficiently genuine, will remain from the transition period through all the subsequent formations, to serve as acknowledged monuments of destruction, as well as of the renovation of what was destroyed. These are the Codices rescripti, in the archives of the Earth, out of which, the antiquarian will one day decipher the almost obliterated traces of her former condition, as well as the history of her changes. Though these conglomerates deviate so much in their nature, and in the character of their origin, from chemical productions, they have yet among themselves this remarkable and common characteristic, that, with few exceptions, the older are much less varied in character, and more extensive in distribution, than the newer, and that, at length, the newest conglomerates become mere local appearances. But, in reference to the main question which engages our attention, we may conjecture that the beds of rocks from which the sea had never retreated, might be assailed by its floods and currents, and shattered to pieces, as happens even in our own time, and the fragments be again reunited into solid rocks, by means of the still remaining dissolved matter in the water. But of many conglomerates it is evident that they have been desposited on the dry land, in the same way as our gravels. Jupiter, who took counsel with himself, whether he would destroy the sinful world with fire or water, and at length decided for water *, may not be so justly considered the author of these appearances, as Saturn, who devoured his children. Or, to be less metaphorical in our language, it may perhaps have been with the origin of conglomerates, as it is in our own day with the origin of fragments of rock and boulders, in which the rock being fractured in various places by the alternations of heat and cold, by the influence of air and atmospheric water, falls into pieces of greater or smaller magnitude, which are carried forward by the water, and gradually rounded in their progress, so that they assume a more perfectly globular shape the farther they are removed from their original situation. Therefore, as regards the foregoing enquiry, it is not an unimportant circumstance, that the long but continual rolling of the boulders during their rounding, appears to be much more efficacious than a rapid and violent impetus, and that, in this case, as in many other geognostic appearances, time rather than force is to be taken into account. Another circumstance, perhaps, corresponds with this, that the change produced by the weather, not only by the first disunion, but also by the progressive disintegration of the rocks, by the blunting of the edges and corners, by the diminution of the fragments, and generally in the origin of the boulders and fragments of rocks of every description, has just as much influence as

---

* "Jamque erat in totas sparsurus fulmina terras,
"Tela reponuntur, manibus fabricata Cyclopum:
"Pœna placet diversa; genus mortale sub undis
"Perdere, et ex omni nimbos dimittere cœlo."
Ovid. *Met.* lib. i. v. 255.

the mechanical operation of the water; and that a great part of the land called Alluvial, generally owes its existence to this cause *. But if, upon farther consideration, the conglomerates appear to derive their origin in a similar way with rolled masses of gravel, they afford evidence, nevertheless, of the elevated station of the water in the neighbourhood, from which they had been before removed; for their conglomeration could take place only under water; and, with few exceptions, they occupy an incomparably greater elevation than any of the coal formations, or any of the beds of rocks which enclose the remains of land animals.

Geognosy certainly contains many facts, which cannot be explained, but by a change from dry land to the bottom of the sea, although our knowledge of them is still so imperfect, that we cannot hazard a probable conjecture respecting the numbers of these changes, whether they commence at the same or at different periods in the various quarters of the world, and whether they are local or universal. These changes appear neither sudden nor violent, such as we consider revolutions of the earth, but at all times proceed with silent and regular steps, and depend upon similar causes, concealed it is true from us, such as the universal retreat of the waters from their original height to the present bed of the ocean. We do not belong to those geologists who divert the world from its axis for the purpose of explaining the inequalities of its surface, at whose command the Earth sometimes opens her bosom to engulf the sea, and at other times the floodgates of Heaven are lifted

---

* Vide note on the Non-mechanical Action of pure Water.

up to pour down another ocean. He who reflects on the devastation caused by earthquakes, inundations and the fall of mountains, even though they are merely local appearances confined to particular quarters, cannot help putting the question to himself, how the order, regularity and connection exhibited by strata of rocks, could in in any measure exist, if the same or similar accidents had happened throughout the whole world, and if mechanical power had operated with such energy, and to such an extent? All our knowledge of the structure of the earth, and of the existence of its inhabitants, declares rather a quiet uninterrupted and continually progressive advancement in its formation and development.

In the lapse of geological epochs, we observe a gradation of rock formations following one another, in which the latter, however remotely connected, still appear sufficiently similar to the earlier to indicate a common origin, till they at length terminate in simple formations, resembling those which are presently taking place. When the precipitates were exhausted, and the structure was completed, nay, even earlier, its destruction commenced; not that violent destruction by which lofty mountains are torn asunder and levelled, no uproar of nature, no gigantic struggle of the elements, such as we commonly conceive, but a decomposition of the strata of rocks to a greater or less depth, caused partly by chemical, partly by mechanical, but slow operating powers, what they wanted in intensity being compensated by the endurance of their operation. According to the common law of nature, deficiency of power is supplied by duration of time; for, of all the oracles which have been consulted concerning the formation of the earth, there is no one which can make such important revelations to us as the oracle of the age of mountains. These operations at the earth's surface generally appear to have produced its present figure, and to have designed it for the habitation of numerous organic beings. This appears as early as a suitable element occurred; first, in water, then in land animals; and, like the formation of rocks, we observe a regular succession of organic formations, the later always descending from the earlier, down to the present inhabitants of the earth, and to the last created being who was to exercise dominion over them. But here occurs this important distinction: the organic world with youthful vigour renews itself daily, and decomposes its materials only to reunite them by fresh combinations in uninterrupted succession; while the powers of the inorganic world appear almost extinguished. Though this course of nature is manifest to our own observation, her resources and progress are, on the contrary, more concealed; and we can hardly lift the veil which conceals her, unless we follow Bacon's advice, Turn back from rash theories, and follow observation and experience.

We have hitherto endeavoured to shew that incontrovertible geognostic facts indicate an alternate rising and falling of the water which covered the earth's surface, but that they were not of a kind to justify the notion of violent revolutions, or of sudden and universal eruptions of the sea; and that, therefore, such deluges as the Mosaic deluge, recorded in the traditions of nations, were not revolutions of this description. If, according to the supposition of Cuvier, the earth's surface inhabited at the commencement of the latter deluge has become the present bed of the sea, and the former bed of the sea has become the present dry land, then, according to the present state of geography, *though only conjectural*, we should be able to point out such portions of the earth as were overwhelmed by the catastrophe; and yet we have never heard that any one has hazarded such an experiment. In the constitution of the present habitable globe, we find no proofs remaining of such a revolution.

Among these revolutions of nature, we never reckon common inundations, such as take place at present from water overflowing its boundaries, though these also may produce devastation whose effects remain visible for an hundred years. But, in mountainous districts, another kind of aqueous eruption makes its appearance, and may be classed along with the traditions of a deluge. We very frequently, for instance, observe the valleys of high mountains forming a range of basins separated from one another by shorter or longer defiles, and opening through the last defile into a wider valley, or a marsh. The shape of these basins, or cauldrons, commonly lying above one another like so many stories, and the level surface of their water, leave no doubt of their being once enclosed lakes which were formerly blocked up by the barriers of the defiles, and which flowed towards the level country, as soon as the defiles were broken down by the waters. If no kind of historical monuments in the west of Europe bears evidence of those events, which, at least on a small scale, occur in our own times, this intimates that it was inhabited, not by an original population, but by a foreign or modern race of people; whereas those revolutions extended to remote antiquity. The numerous masses of rock found on both sides of the Alps to the height of

4000 feet, as well as in the plains of the north of Europe, at a great distance from their original position, and concerning whose coming hither so much light has lately been thrown by Messrs Buch and Escher, are a very probable proof of these debacles; while every circumstance renders it evident that these blocks were swept along by the currents thus created, to the place where they are now found. The Greek writers have also preserved accounts of such revolutions, which, although not unquestionably authenticated, are yet stamped with the impress of historical testimony. Herodotus has the following passages directly relative to the country where the Greeks place their second or Deucalionic deluge. "Thessaly must formerly have been an inland sea, surrounded by high mountains. On the east it was bounded by Pelios and Ossa, whose bases were united; on the north by Olympus; on the west by Pindus; and on the south by Othrys. Thessaly lay in the midst of these mountains in the form of a basin, into which, in conjunction with other copious streams, the five well-known rivers, the Peneus, the Apidanus, the Orochomenus, the Enipeus, and the Pamisos, emptied themselves. These rivers, which are collected in their basin from the mountains which encompass Thessaly, after their junction under the name of Peneus, in which they lose their former appellation, open towards the sea through a narrow valley. According to tradition, this valley and opening did not formerly exist; so that the rivers and the Lake Brebeis, which did not formerly bear these names, having their confluence in this place, rendered the whole of Thessaly an inland sea. The Thessalians affirm that Neptune opened the valley for the passage of the river Peneus, and they may perhaps be right. If we consider Neptune the author of earthquakes, and consider the violent concussion of the mountains caused by them as the work of this deity, we must, upon surveying these regions, confess that they owe their present shape to him; for the separation of every mountain appears to me to have been produced by some violent commotion of the earth." Strabo makes mention of this tradition, which he thought worthy of belief, and accounts for the origin of the Vale of Tempe, which is the bed of the river Peneus, and likewise for the separation of Ossa from Olympus, by means of an earthquake [*]. In making this remark, we perceive that our theories which allow that earthquakes are to operate in forming the surface of the earth, have not even the merit of novelty. According to the last writer, similar eruptions of water must have originated in the lake Copais in Bœotia [†], in the lakes Bistonis and Aphnetis, in Thrace, and have been accompanied with huge devastation [‡]. Diodorus Siculus [§] remembered a Samothracian tradition, according to which the Euxine

---

[*] T. ix. c. 6. Claudian describes this occurrence in the following words:

> " Cum Thessaliam scopulis inclusa teneret
> Peneo stagnante palus, et mersa negarent
> Arva coli, trifida Neptunus cuspide montes
> Impulit adversos: tum forti saucius ictu
> Dissiluit gelido vertex Ossæus Olympo."
>
> *De raptu Proserp.* l. ii. v. 179.

[†] L. i. c. 3.

[‡] According to Wheeler, who was on the spot, it appears to have broken through the Mount Ptous.

[§] Bibliothec. Historic. l. v. c. 47.

Sea was once shut up on all sides. It afterwards burst through its mighty mound of *kyanischen* rocks to the Hellespont, and inundated a great part of the coast of Asia, as well as Samothracia itself. An objection started to the possibility of such an event is, that, from the observations of Olivier and General Andreossy, the shores of the Black Sea are, in most places, lower than those of the Bosphorus; and that its waters, therefore, even if they were considerably higher than they are at present, would more readily overflow the former than the latter. But since every rock exposed for such a length of time is daily crumbling down, it is a question, whether the shore of the Black Sea has undergone any alteration since that period; and we know that the eruptions took their direction, not so much from the low situation of the barrier, as from the nature of the rock of which it was constructed, being influenced by the weather, and from the rock itself being rent asunder. Be that as it may, the words with which Diodorus commences his narrative are remarkable, when he says, the Samothracian deluge happened earlier than those of other nations. It at least so far preceded others, that, in the estimation of the Greek historian, independent of the deluges of Ogyges and Deucalion, similar natural occurrences more or less authenticated were received as historical facts.

Finally, the effects produced by the bursting of lakes or debacles do not appear to be out of proportion to the devastation mentioned by the traditions of nations. To abide by our former example, floods which could carry along with them masses of rock of 50,000 cubic feet, were in a situation to bury a whole people; and the few individuals who might be preserved would undoubtedly have handed down the memory of such an event to remote posterity. Other deluges may have arisen from other causes, at a time when, as is shewn by numerous vestiges, lakes and rivers had a much greater elevation than at present; and, therefore, every overflowing of them must have produced greater and more extensive ravages.

From these last local eruptions of water, that is, from single limited districts, arose the mechanical precipitates known under the denomination of Alluvial Soil. Their situation, as the uppermost covering of the earth, as well as their origin, which takes place beneath our own observation, furnishes evidence of their being the most recent mineral formations; and it follows from their nature and connection that they were not produced by chemical means, but removed by the mechanical force of water. Since they, among other things, contain prostrate forests, and abundant remains of land animals, we conclude that they did not originate in the bed of the sea, but were floated and deposited upon the dry land by an overflow of land water. How is it conceivable that these precipitates have been covered by the ocean, since their deposition, and have, by means of an opposite change, become the dry land they are at present; and yet it must have been so, if they are to be considered as intimations of the Mosaic deluge.

The view now given, which is that of Henger in his Beiträge, is also advocated by other naturalists, and has lately been brought forward in an interesting manner in the Edinburgh Philosophical Journal*. We have been frequently requested to give the two views, in regard to the universal deluge, namely, that which maintains that it is proved by an appeal to the phenomena of the mineral kingdom; the other, which affirms that that great event has left no traces of its existence on the surface or in the interior of the earth. M. Cuvier's Essay, and Professor Buckland's Reliquiæ, are the best authorities for the first opinion; while numerous writers have advocated the second.

---

* Vol. xiv. p. 205.

Note, p. 244.

ON THE ACTION OF RUNNING WATERS.

A very great degree of power has been attributed to the waters which move at the surface of the earth, or in its interior. Many geologists have advanced the opinion, that they have scooped out the channels and even the valleys in which they flow, and formed the cliffs whose feet they wash; and many philosophers, naturalists and even geologists, still support this opinion, not only in some of its applications, but even in its whole extent.

In order to appreciate it, it is sufficient to observe with care the different modes of action of water set in motion by different causes, and the changes which it has operated upon the rocks and deposits upon which it has acted, from the most remote times to which history may reach.

We must, in the first place, successively examine the different sorts of action of the principal masses of water which are in motion at the surface of the earth, that is to say, the action of torrents, of rivers, of currents of the sea, or of great lakes, and that of waves.

We shall afterwards see what consequences are to be deduced from these observations.

1. *Action of Torrents.*

Torrents have a true degrading and *scooping* action upon the earth's surface, but, by the necessary consequence of the sense which we attach to the word, this action cannot be exercised upon spaces of great extent, for a torrent is a water-course which has a great declivity. Now, on account of the little height which the most elevated summits of the globe have in comparison with the extent of its surface, this action cannot be very extensive; it can only, therefore, produce short and narrow ravines. This action, as all who have visited high mountain chains may have seen, is only often local and instantaneous; it presents no remarkable effect but upon the heaps of debris which cover the declivities of the mountains, and on broken rocks, partially disintegrated by other causes, and lastly on moveable deposits. The results of this action contribute to confine it within narrower limits still, by heaping up at the mouths of torrents in the valleys or plains, the debris carried down by these torrents. The elevation of the soil, which necessarily follows from the accumulation of these debris, diminishes with the declivity, the rapidity, and consequently the power of these water-courses.

Great masses of water moving rapidly, have a marked transporting power. Striking examples of this power have but too often been seen in Holland, by the breaking down of the dikes, and in Alpine mountains, in consequence of extraordinary rains during tempests, or from the rupture of some of the natural barriers of lakes. In these latter times (in 1818), the Vallée de Bagne experienced the terrible effects of this devastating power.

Masses of ice having fallen towards the upper part of this valley, and accumulated there, raised a dike sufficiently compact and strong to block up the course of the Dranse. The waters of this river, rapid and pent up in certain parts of its course, as are all those of the high Alps, accumulated above this barrier of ice, and formed a lake which attained, at its maximum, 130 metres of mean breadth, from 3000 to 4000 metres of length, and 36 of mean depth, and consequently a volume of water estimated at about 29,000,000 cubic metres. Although, by means of operations conducted with equal skill and courage, about the third part of this volume was let off without danger, the remaining part having suddenly broken through the barrier of ice, was precipitated with an almost unexampled impetuosity of 11 metres in the second, into the Vallée de Bagne. In the first part of its course, and in the space of half an hour which the mass of water took in traversing a league, it carried away trees, dwellings, enormous masses of debris, and rocks *already separated from their mass*, as M. Escher, expressly says; it covered all the broad parts of the valley with rubbish, pebbles and sand, and carried the remainder of the substances which it had swept away, as well to the extremity of the valley, towards Martigny, as into the bed of the Rhone. The mass of water took an hour and a half in rushing from the glacier to Martigny. The same event took place from the same cause, and with nearly similar results, in 1595.

Torrents may therefore scoop out ravines in certain formations, and produce effects which appear considerable, because we judge of them by comparison with our own feeble means. But how diminutive and circumscribed are these changes produced in the configuration of the globe, compared with the long and broad valleys which furrow in vast numbers the immense surface of the earth, and to the formation of which neither the torrents nor great rivers which exist at the present day have in any way contributed, as we shall presently demonstrate.

2. *Action of Rivers.*

The action of *rivers* must be examined under two very different circumstances, or at two different parts of their course.

First, When they are compressed between mountains, whether at no great distance from their source, or even at the middle of their course.

Secondly, When they have reached broad valleys, whose declivity is slight, or plains which commonly surround their mouth.

In the first case, these rivers partake of the impetuosity and power of torrents. They often run with rapidity, and in great quantity, at the bottom of narrow and deep valleys: they are as it were inclosed in channels, whose vertical walls appear as if cut by art. The first idea which presents itself to all who have seen these appearances for the first time, and who are satisfied with first impressions, is, that these streams, which are pretty powerful and always very impetuous, have dug these deep grooves; and if sometimes the hardness of the rocks and the height of the precipices which form their sides, appear too great for those small streams that meander at their feet, what cannot be attributed to their immediate power is attributed to the continued action of time.

Without examining how long a series of ages it would be necessary to admit, before the rivers which we have mentioned above, and the water-courses encased in the deep valleys of the Alps, Pyrenees, Jura, Grampians, &c. could have scooped their valleys, on which their present action is so slow that no one has yet been able to estimate it; without examining if this long series of ages agrees with the phenomena, which preclude our attributing so remote an antiquity to the actual state of the earth's surface, a question of too much importance to be treated indirectly; it will be sufficient to mention here four sorts of observations, in order to be persuaded, or at least to suspect, that the present rivers, even supposing them ten times the size that they are, could not have scooped out the deep channels at the bottom of which they run.

1. We must recur to the period when the ranges of hills which border the present valleys were not as yet scooped out, but were united in such a manner as not to leave any hollow between them, or merely a slight original depression.

This shallowness of the valley would be accompanied with an inconsiderable slope of its bottom. If, then, we suppose the same mass of water, it must run with less quickness, and consequently with much less power; and yet a very great force must be attributed to it, before it could have had the power of removing a portion of rock nearly represented by a recumbent triangular prism, having often 500 metres of breadth by a sometimes equal and often much greater vertical thickness. If, in order to get rid of this difficulty, we admit a volume of water incomparably larger than the present volume of the rivers to which so great effects are attributed, we must admit much more elevated and more extended mountains, to give rise to so great a volume of water.

Were we only detained by this hypothesis, and did not direct observation oppose itself to the admission of this disaggregating power and its effect, we might pass it over; but two other observations render the hypothesis inadmissible.

2. Historical records equally concur to prove that the rivers possessed of the greatest power which can be attributed to them, have no appreciable corroding action upon the rocks on which they move.

No one has maintained that the greater number of the cascades, cataracts, or rapids, long known and mentioned on account of their celebrity, have disappeared or have even sensibly diminished, nor consequently that the natural dike which the water had encountered in its course, has been worn or even completely disrupted. We do not find that cascades have changed into cataracts, and these again into rapids. The cataracts of the Nile have been spoken of from time immemorial, as always opposing an obstacle to the navigation of that river; the same is the case with those of the Danube, of the fall of the Rhine at Schaffhausen, &c. The famous cascades of the Alps and Pyrenees have been cited ever since writing was in use; and among all these examples we can scarcely find two or three cascades that have been lowered, or cataracts reduced in their level.

The only cascade which we can point out as having really diminished in height, is that of Tungasca in Siberia. We do not, however, assert but that there may be others. So many causes different from those of erosion may concur to lower a cascade, or even make it disappear almost entirely, that we are rather astonished at the small number of examples mentioned, than embarrassed by the objections which these examples might present to the opinion which we are defending: for the fall of a part of the rock which forms the cliff from which the cascade is precipitated; an abundant accumulation of debris at the foot of the cliff; a real destruction of the softer deposits, forming part of the strata of the mountain from which they fall, are sufficient causes for changing the height of waterfalls. These causes must present themselves pretty frequently; but how different is their action from that of erosion? This, if it existed, would extend from the source of the river to its mouth, and would have a considerable influence upon the configuration of the earth's surface. Those which we have mentioned have, on the contrary, an action so limited and so local, as to be scarcely appreciable.

3. Allowing, for the moment, that a river, possessed of a vast erosive or disaggregating power, may have scooped out the valley in the bottom of which it at present flows, in a state of feebleness very different from its original state, we must account for the disposal of a vast mass of earth and rock, which filled up the valley before the river had removed it. It is not possible to suppose that it has been transported into the sea, which is often more than a hundred leagues from the valley; for we know that when rivers, on reaching the plains, lose their rapidity, they allow the matters to be precipi-

tated which they held in suspension. Besides, we have shown that many rivers, on leaving the mountains, traverse lakes, in which they deposit all the earthy matters suspended in their waters. This deposition is particularly striking in all the considerable rivers, which descend from the ridge of the Alps toward the north-west and south-east of that chain of mountains. These rivers meet, at the opening of the valleys they flow through, lakes, which they traverse, and which seem intended for their purification. Thus, on the northern side, we see the Rhone traversing the lake of Geneva; the Aar, the Lakes of Brientz and Thun; the Reuss, the Lake of the Four Cantons; the Linth, the Lake of Zurich; the Rhine, the Lake of Constance. On the south side, the Lac Majeur is traversed by the Tessin, the Lake of Como by the Adda, the Lake Disco by the Oglio; the Lake of Guarda by the Mincio, &c. Now, these lakes, which are only themselves deeper parts of the valley, would have been filled up by the debris conveyed to the valley, if this valley had the origin attributed to it. Proceeding from one hypothesis to another, it might perhaps be supposed that these lakes may have been sufficiently deep to swallow up all the debris of the valley, without being chocked up. But, rather than admit such suppositions, why not grant that the same unknown cause which has scooped out the lake, has also scooped out the valley which is only a continuation of it?

4. But if facts had proved that the waters degrade the rocks, scoop them out, and perpetually remove their debris, we might perhaps be induced to admit that unknown causes, of which we are absolutely ignorant, and of which we can form no idea, have given to the original

rivers the means of surmounting all these obstacles. Now, observation would seem absolutely to prove the contrary.

We have remarked, that rapid rivers which, in the bottom of valleys, fall in cascades, from rock to rock, which beat with violence against the walls which contain them, do not in any degree alter these rocks, and that, far from corroding their surface, they allow it to be covered with a rich coating of mosses, confervæ, &c. which could neither maintain itself, nor be formed at all, were the least portion of the surface of these rocks continually or even only frequently removed.

A much more striking fact is that which some of the great rivers present, such as the Nile, the Orinoco, &c. which flow in the equatorial regions.

These powerful rivers, when they have arrived at places where they are contracted, and, as it were, jammed in between two rocky walls, form impetuous cataracts. Their waters, endowed by the celerity of this fall with the greatest erosive power that can be attributed to this fluid, must necessarily have corroded, or at least worn, the rocks which they have thus beat against since the creation of our present Continent. Now, so far from removing the surface, they cover it with a brownish varnish of a peculiar nature.

It appears, therefore, well established, that water *alone* does not scoop those rocks, whose aggregation is complete, or which are solid; and that it does not wear them in any way, whatever be its quantity of motion.

We say *water alone*; and we must insist on this distinction, in order to make the preceding facts agree with other facts, which might seem contradictory.

We often see furrows scooped out on the walls that bound the narrows of rivers; we also see rocks rounded, and entirely destitute of moss. But let the facts be examined with attention, and we shall find that this erosion always takes place in the parts of their course, where, on account of the nature of the neighbouring soil, the torrents carry with them, in their risings (or floods), debris and detached stones from their banks; and it is by means of these stones that they wear the rocks which are in their bed.

It is very easy to appreciate these circumstances. It is remarked, that this erosion has never taken place at the sources of powerful springs. All the pebbles which had to be carried off have been so long ago, and the mosses which grow abundantly on the rocks at the level of the water, and in the bed of these torrents, have nothing more to fear from the destructive action of these solid bodies. The case is the same with the parts which immediately succeed a lake, or a great excavation, capable of arresting all the hard bodies carried off by the river. There the mosses appear in abundance; because they are not subjected to the action of any other substance than of the water alone.

The present rivers do not therefore appear to have any erosive power upon the rocks which are completely aggregated, when they act by themselves, and when no other cause, such as frost, decomposition, &c. has disintegrated the rock. The absence of these foreign circumstances is proved by the vegetation or the enamel which then cover the rocks exposed to the action of the water.

These rivers, in proportion as they remove from the rocks in the neighbourhood of the lofty mountains in which they took their rise, often gain in volume what they have lost in velocity; but the power dependent upon size rarely compensates that which they owed to rapidity; and although these large rivers still retain a transporting power, sufficient to carry along with them the obstacles which oppose themselves to their progress, they are far from presenting results of action so striking as those of torrents. They stir up, when flooded, or when they change place, the earth and mobile sand which cover their bottom, especially towards their edges, and transport them to some distance; but they scarcely move pebbles larger than an egg, which occur in their bed, and which have been brought there in other times, and under other circumstances. On thus transporting the comminuted and mobile mineral matters, they deposite them again in places where their current is relaxed by some cause, and thus raise the bottom of their bed in these places; they seek a new passage in the midst of the barriers which they have themselves constructed. The principal current is then borne, sometimes against one bank, and sometimes against the other; and when it comes to beat upon the foot of a steep part, composed of moveable soil, as the banks commonly are, in such cases, they really erode it, and make it fall into the river; and transport to another part of its course, the earth resulting from the destruction of the bank, and give rise to new obstacles. Hence the new deposites, which border rivers in all points where their current is slackened, and principally toward their mouth. It is sufficient for our present purpose to have referred to facts remarkable for their number, for the importance which they have had in regard to the modern changes of the configuration of the globe; and, lastly, in regard to agriculture and civilisation; —facts of easy observation, and which tend to prove, that the action of rivers, whose fall is not sufficiently rapid to entitle them to be considered as torrents, is not to scoop out their bed, either in the valleys or in the plains through which they flow, but rather to raise them, and to tend, consequently, rather to level and flatten the earth than to furrow it, more than it has been since the Continents have assumed the configuration which they now possess.

But if we have not been able to recognise a real corroding power in the great rivers falling in the form of cascades or cataracts, let us inquire elsewhere, in circumstances where the water seems endowed with a still superior power, what are the effects of this agent?

3. *Action of Waves.*

It is in the sea, an enormous mass, sometimes acquiring, from the action of the winds, an incalculable power, that we must find the maximum of force of the water of the *present* times. In fact, in this case, the power of transportation is so prodigious, that the strongest barriers, both natural and artificial, are overturned, and the largest stones, together with enormous fragments of rocks torn from their place, transported, and even projected to a distance. But it is to these effects that this immeasurable power is limited. The water, which displaces and transports to a distance these heavy masses, does ot abrade the surface when it acts by itself. We see this urface, on rocks and the sides of piers and dikes, pertually beaten by the waves, covered with fuci, conrvæ, byssi, and other delicate vegetables, *without roots*, hich the waves have not prevented from contracting r first and feeble adherence, and which they do not inder from growing. But, if the waves carry with them pebbles, or even sand, it is those hard bodies which act; the surface of the rocks is abraded, and all vegetation ceases.

The same effect takes place, and is even augmented by the real degradation of the coasts, if the sea acts upn friable rocks, capable of mixing with water, such as argillaceous or calcareous marl, or chalk, or upon rocks which are hard, but naturally fissured, or partly disaggregated, such as certain granites; it then easily removes the crumbled or previously detached parts, scoops out the foot of the rock or steep coast, and causes the upper part, which is deprived of support, to fall. But, in consequence of this fall, it forms a slope, which, by its inclination, deadens the violence of the shock, and even protects the foot of the cliff, for some time only, if it be friable, or capable of disintegration; and for ever, if, being compact, it does not carry in it the causes of destruction. The action of the waves ceasing, the slope is covered with vegetation; and if the coast continues, nevertheless, to be worn, the changes are then owing to causes unconnected with the action of water.

Such is, in few words, the ordinary action of the water of the sea upon steep coasts, and even that of great masses of water in a state of agitation. M. De Luc, in his various works, has estimated this action with a correctness of observation and of reasoning, which is remarkable only, because it has not been adopted by all naturalists; and few have bestowed the unremitting attention upon the subject which this respectable geologist has done. He has shewn, that the destructive action of the waters upon steep shores, and other coasts or abrupt cliffs, was considerably restrained by the very consequences of this action; that the debris which accumulated protected the lower parts of these coasts from the action of the water, or gradually reduced an abrupt coast to a very inclined and permanent slope.

Next, to *torrents*, to rapid and large *rivers*, and to *waves*, it is to *currents* that a great influence on the earth's surface has been attributed,—an influence which a highly gifted naturalist, Buffon, has employed to explain all the inequalities of the earth's surface.

Our knowledge of the action of currents is less precise than that which we possess of rivers. But if we cannot so visibly demonstrate that, in no circumstance similar to those which we have specified, do they *scoop out* the bottom of the sea into valleys, nor form any mountains, we can, at least, conjecture with much probability, and maintain, that we have no direct and constant proof of that action.

4. *Action of Currents.*

No one doubts that currents, near coasts, heap up upon the beach, at the mouth of rivers and harbours, pebbles, sand, gravel, mud, or other transportable matters, whether these currents constantly exist, or simply result from the momentary action of a predominating wind; but this action, although already limited to the mobile matters which form the bottom of the sea only in some parts, whether this action, I say, extends to a great depth, that is to several hundred yards, is a question not yet resolved. In the first place, the observation made by mariners, that, in the most violent tempests, the sea is only agitated towards the coasts, or on shallows, and that bodies, sunk to a great depth, (and still what is this depth in comparison with that of the sea,) do not feel the motions of its surface, nor that of currents; and, secondly, reasoning, and even calculation, according to Messieurs La Place and Poisson, concur to shew, that the violent motions of the waters of the sea are not propagated to a great depth. It is therefore probable, that all the transportable matters, which are at this depth, must remain nearly in the position in which they are, since our Continents have assumed their present configuration, unless phenomena and motions of the sea take place at the bottom, of which we are ignorant, and which are foreign to the subject which at present occupies our attention.

But if we have no perfectly certain ideas regarding the propagation of the motions of the sea in depth, we can assert, that, whatever that extent and that power may be, the submarine currents no more abrade the rocks than rivers do the surface of the land. This proof is always derived from the same kind of fact, namely, from the vegetable and animal bodies which constantly cover the rocks, and which are found, at all times, by means of various sorts of dredge-fishing. In fact, no one has remarked, that the places in which oysters, mussels, corals and sponges are fished, are more sheltered from currents than others; nor that these places, after violent tempests, have been deprived, and consequently, as it were, despoiled of those productions, which, by covering the rocks, demonstrate that they preserve the integrity of their surface. Many of these bodies, however, as sponges, fuci and confervæ, contract but a feeble adherence to the bodies upon which they are placed.

It therefore appears, if not completely proved, at least extremely probable, from the facts and reasonings which we have related,

1. That the *presently existing* waters, that is to say, in the state of purity in which we are acquainted with them, have no erosive action upon rocks, whatever be the nature of these rocks, when, 1st, the rocks are completely solid, and when they are neither friable nor disintegrated; 2d, When these waters act by themselves, that is to say, when their action is not complicated with the really erosive action of solid bodies, such as pebbles, sand, and perhaps even pieces of ice.

2. That water, sometimes acquiring, on account of its quality and velocity, a great transporting power, may remove masses, already detached, and of great size, according to its degree of velocity, and the bulk of its mass, and so far as it preserves this same power.

3. That the presently existing waters may have attacked, undermined, and caused to fall down, portions of solid and steep rocks, by mixing with beds of clay, marl, and sand, interposed between their solid strata; that they may also, in their rapid falls, have scooped pretty deep ravines in very inclined deposites, consisting of disintegrated rocks; but that these waters could not

have scooped out, either by a violent action, or by a slow one, however long continued, any of those long and broad longitudinal depressions, which are named valleys, or of those narrow openings, with almost vertical walls, which are named *gorges* or ravines.

4. That, even when the deposites, which border these valleys or these ravines, are composed of transportable matter, the waters which at present flow in them could not have scooped them out, even supposing them to have been much larger in some than they now are; the declivity of the present deposite not being sufficiently great to give to these masses of water the rapidity necessary for producing this effect, and a power sufficient for carrying off the moveable matters which filled the valley or gorge.

5. Lastly, that the present running waters, so far from having contributed to form the numerous valleys, glens, gorges and ravines, continually tend to fill them up, and rather to level the surface of the globe than to furrow it, more deeply than it is.

Vid. Brongniart *sur l'Eau.*

NOTE

On the Connection of Geology with Agriculture and Planting[*].

THAT all sorts of soils are not equally adapted to all productions, is a remark of Virgil's, the truth of which becomes obvious, when we consider many facts ascertained in Agriculture and Forestry. If, therefore, as the poet advises, our object be to determine what each particular region can produce, and what it cannot, our attention ought in the first place to be directed to the physical circumstances which exert their influence over vegetation.

---

[*] The remarks on the connection of geology with agriculture and planting, are inserted here as an illustration of some of the details in the body

All plants that are the subject of cultivation are fixed in the ground. By one of their parts, through which they derive their principal nourishment, they penetrate into the soil, which serves them as a basis, and affords them the means of procuring subsistence; by the other part they raise themselves into the atmosphere, which is not only necessary in itself for their existence, but is also the medium through which they derive the warming and vivifying influence of the solar rays. Hence we can understand how much the existence of plants must be influenced by differences in the condition of the soil and air.

The superficial crust of the globe is formed of soil capable of producing vegetables. This productive soil, however, is not everywhere continuous, being interrupted on the one hand by the watery covering of the earth, and on the other by perennial snow and bare rock. Where soil does occur, it separates the solid mass of the earth from the atmosphere, and is the porous medium through which the gaseous and watery parts of the latter may act in a greater or less degree upon the former. It is very seldom that strata of vege-

---

of the work. They will, we think, be useful to students of agriculture and geology, and interesting to the general reader.

table soil lie beneath strata of other matters; and where they occur in this position, the overlying strata are either of volcanic or of alluvial origin. Of the former case, a very remarkable example occurs in the Isle of Bourbon, in which large tracts covered with vegetables and even trees, have been laid waste and overwhelmed by streams of lava; and large rivers in their overflowings occasionally leave deposits of various characters, over the productive soil containing remains of formerly existing plants.

Productive soil, as well in regard to its *situation* as to its *constitution*, depends upon the nature and condition of the rocks which form the solid mass of the earth. It is always of secondary formation, compared with the rock on which it rests, its principal parts usually originating from the decomposition of this rock. While the forms of the surface of the solid mass of the earth, have much influence upon the action of the atmosphere, they also in some degree modify that of climate. From these circumstances it would appear that the solid substrata of productive soil exert an influence in various ways upon vegetables; whence it follows that, in order to obtain a more intimate knowledge of the conditions which operate upon their existence, it is necessary to call in geology to our assistance.

Although the scientific study of agriculture has made great progress in our times, the relations which exist between the constitution of the solid crust of the earth, and the formation and nature of vegetable soil, present a wide field for investigation. Geologists have hitherto too much neglected the examination of the productive covering of the earth, and those who have treated scientifically of agriculture and forestry have usually looked upon the vegetable soil in its own simple capacity, without regard to its foundation and origin. To point out the way by which we are to proceed in our investigation of the relations which exist between the solid crust of the earth and the productive soil which covers it, is the principal object of the following observations.

Bare rocks cannot be made subservient to the purposes of agriculture. Lichens indeed, cover the surface of rocks, deriving their chief nutriment from the atmosphere; mosses draw the water necessary for their subsistence from the fissures of stones; the roots of grasses seek in the chinks of rocks for particles of earth sufficient for their sustenance; various shrubs and trees penetrate here and there into rocky masses by their roots (having the powerful and continued action of living wedges), where the cohesion of the parts is smallest, in order to prepare a fixed seat for themselves, and be secure from the pernicious effects of the atmosphere. The surface of the earth is always sterile, however, when it shows a continuity of naked rock, uncovered by vegetable mould. The cultivation of fields and woods, and even the rearing of cattle, cannot therefore find scope in regions which are entirely rocky. Abrupt and precipitous mountains being generally in this condition are usually barren; but in plains and on declivities, a bare rocky surface is much less frequently the cause of sterility than an unfavourable proportion of mould. Some rocky and moderately elevated regions also occur, more or less destitute of vegetable mould, whose sterility depends upon volcanic causes. Iceland, for example, affords cases of this description. In many parts of Sweden, as in Westrogothia, in Scotland, &c., there occur many elevated regions, in which gneiss and granite predominating, exclude to a great extent all kinds of vegetation excepting lichens. In the same districts we sometimes meet with pastures and corn-fields interrupted here and there by bare rocks rising but little above the surface, by which the value of the ground is much diminished, and great impediments opposed to its cultivation.

As bare rocks are incapable of all cultivation, their distance from the under surface of vegetable mould must also be of great importance. In the plains of the north of Germany, for example, this distance is often so great that a rocky surface is never found, while, on the contrary, in other countries, especially such as are mountainous, the roots of plants not unfrequently touch the subjacent rock; the variation between these extremes being of all degrees. The effect of the distance of the surface of the solid rock from the under surface of productive soil may be both *direct* and *indirect*, and may vary much, not only with reference to the species of rock, but also to the vegetables.

The surface of the solid strata of the earth has a *direct* influence upon the cultivation of plants, because it terminates the extension of their roots, and limits the volume of the soil necessary for their sustenance. As the length and direction of the roots vary exceedingly in different species, the difference of effect with regard to their growth, and the approximation of the rock to the under surface of the soil, must in general be so much the less prejudicial in proportion as the roots decline from the perpendicular; whence it follows, that certain grasses, and some small pasture plants, may grow in very thin layers of soil, where the larger grasses and pasture plants with longer roots, could not find subsistence; and that shrubs and trees, with long perpendicular roots, cannot survive in many places, where others with more horizontal roots may thrive. These inferences are proved to be correct by observations in agriculture and forestry generally known.

Mountainous regions, which are not so elevated but that corn might grow sufficiently well in them, in so far as depends upon the conditions of the air or climate, are yet frequently not adapted for its cultivation, on account of the too near approach of the rock to the surface, or shallowness of the soil, and produce nothing but grasses, and some other pasture plants, among which, however, there is the greatest difference in this respect. *Trifolium montanum*, for example, can support itself on rocky mountains, where T. *pratense* could not grow. *Hedysarum onobrychis* grows luxuriantly on the sunny declivities of calcareous mountains, where *Medicago sativa* (Lucern) does not find a suitable station. The cultivation of this excellent pasture plant in some mountainous regions, especially where the rocks are calcareous, has not proved so advantageous as might have been expected, because the plants have died out in the course of a few years; whereas, in proper places, where its very long roots find a sufficient depth of soil, they usually last for a great length of time.

The vicinity of the rock to the under surface of the vegetable mould, or the shallowness of the soil, seems to be the principal cause why the *Beech* grows better on many calcareous mountains than the *Oak*, which, on the other hand, finds a fitter station on mountains in which sandstone predominates, where the soil is usually deeper. It would seem to be for a similar reason that the *Beech* grows in many rocky districts, for example, on the Hartz Mountains, at pretty considerable heights, especially on the sides of valleys which run to the south, while these places do not admit the *Oak*, which is found in the middle provinces of Sweden and Norway; while the Beech, on the other hand, grows only in the southern parts. From the deficiency of soil, the Upper Harts can produce neither the *Pinus pinea*, nor *P. sylvestris;* the horizontal roots, however, of the *Abies*, or Norway Spruce, are content with the small portion of earth which covers the greywacke and slate, although they cannot find sufficient hold to protect its lofty trunks from being thrown down by the tempest. In some parts of the Forest of Thuringia, where the covering of loose earth is deeper than in the Hartz, the *Pinus picea*, or pitch pine, grows luxuriantly. The common fir, *Pinus sylvestris*, which attains a great height in proper soil, on the contrary, is stunted and distorted on rocky mountains, where the roots soon come in contact with the rock. It there loses the character of a tree, and assumes that of a shrub, as in place of a single upright stem, several branches shoot out, and these, not unfrequently, are creeping or bent.

The different conditions of rocks, especially their structure and their state of cohesion, are of some importance in producing these effects; for the surface of rocks must be detrimental or impervious to the roots of plants, in proportion to the compactness of their structure, and the cohesion of their parts. Schistose rocks, for example, afford a more easy passage to roots, than granular crystalline ones; pure quartz resists the roots of plants in the highest degree; sandstone much less; and pure limestone, on account of its comparatively small number of fissures, is much less favourable to vegetation than marl, chalk, or slightly cohering calcareous rocks, the masses of which are usually split in all directions.

The direction and inclination of the strata have also some influence in this matter; for, in proportion as the principal fissures of the strata are, from their direction or inclination, more readily presented to the roots of vegetables, the less prejudicial will their surface be to vegetation. Horizontal strata, therefore, are the least favourable to vegetation, perpendicular ones the most. In the inclination of strata intermediate in some degree between these positions, the roots of vegetables will find a greater obstacle on the side of a hill in which the surface of a stratum is opposed to them, than on the other, in which the principal fissures of the strata are open. The effects of this circumstance may frequently be observed in mountainous tracts having two principal inclinations, the state of vegetation, and especially the growth of wood, being more prosperous on the one of these declivities than on the other.

The surface of the solid strata of the earth may also have an *indirect influence* upon the cultivation of vegetables. The various *inclinations of this surface* deserve first to be considered, being of the greatest effect with regard to fixing the fertile soil. The horizontal position of a rocky surface is in the highest degree favourable to the stability of vegetable earth; and the greater its angle of inclination, the greater is the danger of its losing the soil upon it. In a highly inclined plane, the imperfect support of the centre of gravity is the sole cause of the loss of earth; in a less inclined plane the diminution of soil is usually caused by water, which produces this effect in a greater or less degree, according to the difference of inclination. In both these modes, by which a removal of soil is produced, the effect may be modified by a difference in the condition of the loose earth, as not only its stability as to situation, but also its resistance to the power of water, vary according to the size, figure, and cohesion of the parts, as well as their adhesion to the surface of the rock. Sandy loose soils, for example, are more liable to transposition than marly or loamy ones; and these, again, are more easily moved than such as are clayey and adhesive.

Whatever be the nature of the soil, a small degree of inclination in the solid rock is sufficient to favour its denudation by the removal of the former; and the inclinations of the surfaces of rocks having a covering of earth and vegetation, are in reality much less considerable than we usually suppose them to be, judging merely by the eye. The celebrated Humboldt has published observations on this subject. According to his measurements, a slop of even fifteen degrees appears steep, and a declivity of thirty-seven degrees is so abrupt, that if it be covered with a dense sward, it can scarcely be climbed. The inclination of the pastures of the Alps seldom exceeds an angle of ten or fifteen degrees, and a slope of twenty degrees is pretty steep. At an inclination of forty degrees, the surface of the rock is sometimes covered with earth bearing a sward, but at a greater inclination the rocks are usually destitute of soil and vegetation.

In the Upper Hartz, the most common inclination of the declivities of the mountains is twenty-five degrees; nor does it usually exceed thirty-three, at which inclination the *beech* and *spruce* grow. The greatest declivities at which ground can be advantageously cultivated have an inclination of thirty degrees.

The roots of vegetables, especially of grasses, shrubs, and trees, are of much importance in supporting the earth upon the declivities of rocks. Care must therefore be taken that the declivities of mountains which are covered with turf or wood, be not altogether deprived of these coverings, as sometimes happens in consequence of loosening the turf for agricultural purposes, or of incautiously extirpating the wood. In Norway, near Roraas, there occur mountains, destitute of all vegetation, that had formerly been covered with woods, but where now, from the deficiency of soil, no seeds could take root. The same is the case in many parts of the Alps, where, from the irregular long-continued removal of the timber, the sides of mountains which were formerly covered with thick woods, now show nothing but naked rocks. For this reason, in mountainous countries with very steep declivities, the breeding of cattle and planting of woods are often more advantageous than agriculture. In France the greatest inclination of the public roads is limited by law to an angle of four degrees and forty-six minutes: a similar restriction with regard to agriculture might not be without benefit in certain mountainous countries.

The inclinations of the surface of the solid crust of the earth vary much, according to the different qualities of the rocks; some having a tendency to form abrupt precipices, others, again, to produce gentle declivities.

For this reason, mountains consisting of quartz or porphyry, for example, very frequently present surfaces destitute of vegetation; while, on the other hand, those of granite, slate or sandstone, are more frequently adapted for agriculture and planting. In the northern parts of Scotland, quartz rocks, destitute of all vegetation, rise in the midst of mountains covered with gramineous plants, and sometimes wood. In the most fertile part of the south of Norway porphyritic mountains rise from a calcareous and schistose base, with lofty, rugged, and bare cliffs. In the southern parts of the Tyrol the rocky sterility of the abrupt and lofty porphyritic mountains presents a striking contrast to the fertility of the neighbouring limestone mountains, which are covered with vines, walnuts and chesnuts.

The *surface* of the solid strata of the earth has also an indirect influence upon the cultivation of plants, in so far as the water which the vegetable mould acquires from the atmosphere, is retained in the soil, or is drawn off by the subjacent rock. Different rocks produce very different effects in this respect, depending as well upon their constitution as their structure. The component parts of rocks imbibe water in different modes and degrees; and different sorts of rocks not only attract water with different celerity, but also imbibe different quantities of it. The latter difference depends chiefly upon the various substances of which rocks are composed, partly, also, upon their porosity. Siliceous rocks attract water in the lowest degree, argillaceous ones in the highest, and calcareous rocks appear to have an intermediate action in this respect. Compact and granular crystalline rocks attract water in a smaller degree, and more slowly; friable or crumbled rocks imbibe it in greater quantity, and with more celerity than those which are not disintegrated. The condition of rocks with regard to the attraction of water, affects, in a different manner, the humidity of soil; for, by this attraction, moisture may as well be abstracted from, as imparted to, the loose earth or soil by which rocks are covered. Part of the moisture which vegetable earth or soil derives from the atmosphere passes into the subjacent mass of rock, but this may again be compensated by evaporation; on which account the soil of such rocks as have but a small attraction for water usually dries up more readily than soils whose solid substratum attracts and retains the moisture in a greater degree.

It is probable that the structure of rocks has also a greater, and not less, diversified influence upon the humidity of productive soil. Solid rocks, which are not traversed by numerous perpendicular fissures penetrating to a considerable depth, allow the water to remain in the soil; but columnar and schistose rocks, with perpendicular fissures, and strata declined from the horizontal position, draw off the water from the soil covering their surface, into lower places, where it often re-appears under the form of springs. In these circumstances, we find a partial explanation of the great difference between the humidity of soil covering a surface of solid granite, and that lying upon limestone, which is intersected by numerous fissures. Granitic mountains are often furnished with marshes, whereas, on the other hand, the dryness of the soil upon calcareous mountains is generally excessive *, the cause of which phenomenon

---

* The dryness depends chiefly, if not entirely, on the fissures or divisions in the rocky base of the soil; for, in some parts of Sologne in

is, in a great measure, to be attributed to the circumstances above mentioned. Columella observes, that silex having a moderate covering of earth, preserves to the latter its humidity; and Palladius repeats the remark. In districts which consist of quartzose rocks, not less than of granitic ones, the surface is often covered with marshes. Porphyritic rocks, on the contrary, which have a remarkable segregation of parts, as well as columnar basalt, let off the water to lower places. Springs are very frequently found at the bottom of basaltic mountains; for the atmospheric waters penetrate by the perpendicular fissures to the strata on which the basalt rests, and appear at the place where the two rocks meet.

The effect of different rocks upon the preservation and diminution of the moisture of fertile soil, influences vegetation in various degrees. The retentive power of the surface of rocks is of the greatest importance, where the soil consists chiefly of sand, through which the water percolates, and passes off entirely, unless it meets with a stratum of such a nature, as to obstruct its passage, or comes upon a surface of solid rock. The cause of the sterility of sandy plains is not merely their sandy nature, but also the great depth of the mass or rock capable of retaining the water. The same sand, when covering moun-

---

France, as stated by Mr Arthur Young, and in sundry districts of England, chalk and limestone bottoms are occasionally observed to be retentive and wet. Undergrounds, formed of chalk or limestone, have frequently a thin covering of vegetable mould, from their being, in some cases, over close and wet, and in others over open and dry; the former condition being unfriendly to vegetation and the formation of mould, and the latter too readily permitting its departure when formed, or otherwise favouring the decomposition and waste of that material.

tains consisting of sandstone, has a much less degree of sterility than in those plains, because the surface of the subjacent rock impedes the progress of the water, and consequently retains it in the soil *. It has been sufficiently proved by experiments, that plants can grow in pure sand, when furnished with the necessary quantity of water. A subjacent rocky surface has an entirely different effect upon soil which is very retentive of moisture, upon a clay soil for example, as, in that case, the humidity is

---

* The reason here assigned is confirmed by some observations delivered by one of the latest and most intelligent of the English writers on agriculture. "If," says Mr Marshall, "the several strata" (viz. the subsoil and base) "are of so loose a texture, as to permit the waters of rains to pass quickly downward, without being in any sufficient degree arrested by the soil, the land may be said to be worthless to agriculture." He adds, "Before we suggest any improvement of lands of the latter description, it will be proper to premise, that many of the light sandy soils of Norfolk, which would otherwise be uniformly absorbed to a great depth, have a thin earthy substance, or "Pan," which intervenes between the soil and the subsoil, and which is of such a texture, as to check the descent of rain waters, and thereby retain them the longer in the soil, as well as to prevent the manure it contains from being carried away by their rapid descent; yet sufficiently pervious to prevent a surcharge of moisture from injuring the produce. To this fortunate circumstance is principally owing the fertility of the lands of East Norfolk: for wherever this filter happens to be broken by the plough, or otherwise, the soil becomes unfertile, and continues to be so for a length of years."—(*See Norfolk*, vol. i. page 11.) "This fact aptly suggests the expedient of improving, or fresh forming, a filter of this kind; seeing how capable it is of producing so many valuable advantages; the more especially, as it is probably the Norfolk pan owes its origin to fortuitous art, rather than to nature."—(*See Norfolk*, vol. i. page 12.) "A millstone, or other heavy wheel-shaped stone, made to run upon its edge, in the bottom of the plough-furrow

icreased to a prejudicial degree. In land of this nature, a substratum of rock having the property of drawing off the water would be useful.

The different conditions of rocks with regard to caloric may have some indirect influence upon the vigour of plants. Heat, whether imparted to the vegetable soil by the sun's rays, or generated by various chemical processes in the earth itself, penetrates to the surface of the subjacent rocks, and is more or less drawn from it in a longer or shorter time. Columella observes, that rocks in the upper part of the soil are prejudicial to vines and trees, but in the lower part cool them. The heat of soil will be more or less drawn from it, according to the greater or less conducting power of the subjacent rock. Compact crystalline rocks are probably better conductors of caloric than those which are of looser texture; siliceous rocks than argillaceous and calcareous ones. The influence of the subjacent rock must be greater in this respect, in proportion to the thinness of the superincumbent soil. The effect of the abduction of caloric is more particularly sensible, where the roots of cultivated plants touch the rock, a circumstance

---

(the thickness of its edge being equal to the width of the furrow), by the help of an axle and wheels, would greatly compress a light, porous subsoil. The idea of forming a pan artificially, struck me first in Norfolk; and time and experience have strengthened it. If the experiment be made on a compressible subsoil, as sandy loam, or the soft rubble which sometimes intervenes between an absorbent soil and an open rock, there can be little doubt of its success. But on loose open gravel, which is not sufficiently mixed with tenacious mould to sheath it, and lying on an open base, less utility may be expected from it."

which we often see in vineyards. The vine frequently thrives remarkably on the declivities of mountains, in which it sends its roots among fragments of stones. Experience shows, that the quality of wine is influenced by the different conditions of the stones, among which vines are planted. Albertus Magnus has observed, that the vine thrives well in earth which is mixed with fragments of black roofing slate; and Humboldt remarks, that the vines which grow upon the mountains of the valley of the Rhine, consisting of black clay-slate, afford an excellent wine. At the Cape of Good Hope, also, the vine thrives well in a soil produced by the decomposition of clay-slate, and mixed with fragments of it *. It is probable, that the adaptation of this sort of soil to the cultivation of the vine, depends upon its slow conducting power, and upon its rapidly imbibing the rays of the sun, on account of its dark colour, and thus increasing the heat of the ground.

Hitherto we have only spoken of the *proximate* influence of rocks upon plants; but it cannot be denied, that the *remote* effects which they produce, (inasmuch as vegetable soil is derived from them, and, therefore, the qualities of this soil depend in a great measure upon their nature,) are of greater importance.

It is from the rocks which constitute the crust of the earth, that the principal portion of productive soil is derived. Although other substances belonging to the animal and vegetable kingdoms, are necessary for the nourishment of plants, a soil consisting chiefly of inorganic particles is still more necessary, both for sustaining their roots, and for receiving, retaining, and partly also preparing nutrition for them; for, according to accurate observations, some inorganic substances exert an influence upon the decomposition of animal and vegetable remains. These effects vary much according to differences in the aggregation and chemical nature of the inorganic parts; of which circumstances, however, the different qualities of rocks are the ultimate cause.

---

* *Vide* Dr Adam of Calcutta's Remarks on the Rocks and Soil of Constantia at the Cape of Good Hope, in an early number of the Edinburgh Philosophical Journal.

Two kinds of productive soil may be distinguished with regard to their origin. The soil has either originated in the place in which it now is from the subjacent rock, or it has been transported to the places in which it is now found by some power, especially by that of water. The first kind may be named *untransported*, the second *transported soil.* To the first kind of soil is to be referred a great part of the soil which covers the summits and declivities of mountains, and to the other, the soil which fills the bottoms of valleys, as well as a great part of the loose soil of extensive strata in hilly countries and plains. Untransported soil is generally thinner than the transported; and of the two the latter is that which most frequently occurs in low land. The first kind of soil, the untransported, is found to be more or less similar, in its principal constituent parts, to the rocks from which it has originated; in the other kind, the transported soil, on the contrary, the parts which were originally in connection, have been variously separated and mixed, by the agency of the powers by which its transportation was effected.

The quantity and quality of the soil derived from the disintegration of rocks, must depend upon the nature of these rocks; its quality being determined by the constituent parts of the rock from which it originated, and its quantity being proportioned to the greater or less degree in which the rock may resist decomposition.

The disintegration of rocks, and their conversion into loose earth, are partly *mechanical*, and partly *chemical*. The principal mechanical powers, by which disintegration is effected, are, 1*st*, The weight of the loosened parts; 2*d*, Water, not merely in its liquid and mobile state, but also, and that chiefly, in the state of ice; 3*d*, The roots of vegetables in general, and especially of trees. These powers usually act more or less in conjunction, and the effects produced by this union are in many cases almost incredible.

The disintegration of rocks commences in those parts where the power of cohesion is least energetic. Rents take place owing to the unequal attraction of parts, and also in the direction of planes, in which heterogeneous parts are in contact; and in this manner the original structure of rocks determines the first steps of their disintegration. Water, which enters into the minute fissures of rocks, by the power of capillary attraction, is expanded by congelation, and thus overcomes the cohesion of parts, and produces rents. The roots of trees acting as wedges, produce the same effect in a wonderful degree, a phenomenon which has been so well illustrated by Annæus Seneca, in his Natural Questions. "Let us consider," says he, "how great a power is exerted by the most minute seeds, which, although at first small as they are, can scarcely find a place in the crevices of rocks, yet at length grow to such a size as to rend asunder vast rocks, overturning crags and cliffs, by the power of their very minute and delicate roots." The parts of rocks loosened by these powers, are entirely separated, and are carried to a great or less distance, by streams of water, and in the higher regions, by the power of winds. In cliffs and precipices which have been formed by the splitting of masses of rock, effected in the manner above described, the loosened parts often lose their stability; and, following the direction of gravity, fall to the ground, an effect which has also been described by Seneca in another place. "Nor is it alone probable," says he, "that rocks are split asunder by their mere weight, but also when streams of water are carried over them, the continual moisture works into the joinings of the rock, and daily takes away a portion of the connecting matter, and, if I may so speak, abrades the skin by which it is contained. At length, in the course of ages, this gradual detrition so much diminishes the supporting parts, that they can no longer sustain the weight. Then masses of vast size fall down, and the rock tumbling from its ancient seat, overwhelms whatever lies below." The cohesion of some rocks, especially argillaceous ones, is so slight, and their porosity so great, that their smallest parts imbibe water, and are sensibly softened by it, an effect which is much assisted by the freezing of the water. This mechanical change is experienced by the different varieties of common clay, slate-clay, and some other rocks.

Chemical powers often act in conjunction with mechanical ones, in breaking down rocks, the former, the chemical, frequently finishing what had been begun by the latter. Mechanical powers only changing the *aggregation* of rocks, may break down their parts to a certain size, according to their different nature; chemical powers, again, which change the *nature* of substances, destroy the connection of the minute parts of rocks. When chemical is preceded by mechanical action, it is much assisted by it. The latter has a much more general effect, as all rocks are subjected to its influence; chemical decomposition, on the other hand, acts only upon some rocks, and in these only upon certain parts. The chemical decomposition of rocks is chiefly effected by the oxygen of atmospheric air and of water; but we are also persuaded, that certain cryptogamic plants, intimately attached to the surface of stones, Lichens namely, assist in their destruction.

The oxygen of air and water can only affect the constituent parts of rocks, which have a great affinity to it, such as the iron and sulphur forming pyrites, oxydulous iron, oxydulous manganese, or the same substances mixed with earth or carbonic acid, charcoal and bitumen. Very solid and compact masses of rock, such as greenstone, which are not easily affected by other means, are sometimes corroded by the chemical change of the pyrites contained in them, by which it is converted into a hydrate of iron [*]. In certain other rocks, which are also readily broken down by mechanical agents, clay-slate for instance, the disintegration is much accelerated by the decomposition of the pyrites. The oxydulous iron of felspar is commonly converted by decomposition into a hydrate or ochre. The carbonate of iron, as well as of manganese, which sometimes occur in rocks, in limestone rock for example, are deprived of carbonic acid by the oxidation of their bases. Charcoal and bitumen, which are sometimes contained in rocks, limestone and argillaceous ones for example, are dissipated by the contact of air, so that rocks which were originally of a dark colour, lose it, and become whitish. Water, as a chemical agent, contributes so much to the decomposition of certain rocks, that, either in a pure state, or in combination with carbonic acid, it dissolves their parts, of which gypsum and limestone afford examples. In certain other minerals, in felspar for instance, a separation of the constituent parts, produced by the contact of air and water, is observed, the proximate cause of which has not hitherto been discovered. The mass is decomposed, its lamellar structure is converted into an earthy nature, the alkali contained in the felspar is extracted by the water, a mineral is produced, to which the Chinese have given the name of *Kaolin*, and which is adapted for the manufacture of porcelain. Granite and gneiss occur in some districts, the felspar of which is decomposed in this manner through the whole mass,—a circumstance which must be of great importance in regard to the formation of productive soil.

---

[*] The ochre yellow colour of the decayed greenstone around Edinburgh, and in general in many trap districts in this country, is caused by the decomposition of the imbedded iron pyrites.

Cryptogamic plants covering the surface of rocks, and thriving well in this situation, where more perfect vegetables could not grow, seem also destined to promote the chemical decomposition of rocks,—an effect which they produce both directly and indirectly. As they imbibe the water of the atmosphere, and retain it like a sponge, they keep up a constant application of this substance to the rock, and in this manner contribute indirectly to its decomposition. There are some cryptogamic plants also, which consume certain portions of the rocks with which they are in contact, corrode their surface, and destroy the cohesion of its parts, effects which may chiefly be seen in certain cryptogamic plants attached to calcareous rocks. In this manner one sort of vegetation prepares a place for another, and the most imperfect vegetables are subservient to the growth of the more perfect.

After premising thus much, we shall now proceed to the examination of the principal rocks, in so far as regards their connection with the formation of productive soil, beginning with those which resist decomposition in the highest degree, and ending with those which are the most conducive to the formation of loose earth and soil.

In the first class, we place those rocks which experience no chemical decomposition, in so far as regards their principal mass, and whose cohesion of parts is so great that mechanical powers can only open their natural fissures to a greater extent, and thus break them down into fragments. Of this kind are *vitreous lava*, *pure quartz*, *compact quartz*, *flinty slate*, and *porphyry with a siliceous basis*. On mountains consisting of these rocks, scarcely any productive soil is found, and frequently none at all. They are usually characterized by sterile rocks and cliffs, the bases of which are covered with innumerable rough fragments of stones, retaining their sharp edges for a great length of time, the heaps of which seldom produce any thing else than mosses, which frequently cover the interstices of fragments, occasionally a few grasses, and sometimes a solitary shrub or tree. Examples, Bennevis, Paps of Jura, and Morven Hills. Of all rocks, vitreous volcanic productions are the least capable of contributing to the formation of productive soil. Their dark coloured tracts descend from volcanic mountains to the valleys in frightful sterility, the chinks of their rugged masses scarcely affording sufficient water for the roots of mosses*.

To the second class we refer *compact limestone*, a rock which contributes extensively to the formation of the solid crust of the globe. In so far as regards its principal constituent parts, it is not affected by atmospheric water or air; but, as its parts have but comparatively little cohesion, and are usually separated in a considerable degree by minute fissures, they are more liable to be broken down and crumbled by mechanical powers, than those of the rocks belonging to the first class. In districts where the fundamental rock is limestone, the layers of loose original soil or subsoil are thin, and filled with numerous fragments. As the soil arising from the disintegration of limestone contains a great proportion of calcareous matter, it is neither favourable to the growth of plants in general, nor to that of the greater number of vegetables which are the object of cultivation. Soil of this kind is too hot, dry and stony; hence the reason why districts, in which pure limestone rocks predominate, are often sterile. The case is different, however, where a portion of clay enters as an ingredient into the composition of calcareous rocks, for here the soil is usually very productive; or, where rocks of a different nature alternate with masses of pure limestone, having a greater capability than it of contributing to the formation of productive soil. When water, containing carbonic acid, passes through limestone rocks, it dissolves portions of it, and deposits them in other places, by which the decomposition of the limestone and the formation of loose earth may be in some measure accelerated.

---

* The Streams of Obsidian in Iceland, Lipari, Peak of Teneriffe, Ascension, and Mexico, afford striking examples of the fact stated above.

To the third class belong *chalk* and *gypsum*; which, in so far as regards their decomposition by chemical means, are of a similar nature with compact limestone; but possessing a much slighter cohesion of parts, are more liable to be broken down by mechanical means. Water also dissolves gypsum, and thus assists in its disintegration. The soil arising from these rocks resembles that produced by compact limestone, which explains the want of fertility, observable in certain gypseous tracts of the North of Germany, and in the chalk districts of France. The fertility which we see in certain places where chalk is the fundamental rock, as in the Isle of Wight, Island of Rugen, &c. is to be attributed as well to argillaceous and marly strata alternating with the chalk, as to the greater humidity of the atmosphere, by which the dryness and heat of the soil are diminished.

In the fourth class we place certain rocks, composed of different minerals, but compact in appearance, which, although they resist mechanical disintegration, are yet subject to chemical action, and are, by means of it, converted into a loose, compound productive soil. Of this kind are *basalt*, and some other rocks very nearly allied to it.

To the fifth class we refer those rocks which have a crystalline, granular, or slaty texture. The mutual adhesion of the heterogeneous parts, of which they consist, being, in general, inconsiderable, they are easily broken down by mechanical means, and thus contribute in a high degree to the formation of productive soil. The felspar contained in these rocks, on account of the chemical decomposition which it readily undergoes, has a great effect not only upon the quantity, but also the fertility of the soil produced. The quartz, on the contrary, as well as the mica and hornblende, long resist chemical decomposition; they are, however, useful in this respect, that the argillaceous soil arising from the felspar, has its tenacity diminished; and is consequently rendered better adapted for vegetation, by being intermixed with them. *Granite* and *gneiss*, of all truly granular crystalline rocks, afford the deepest and most fertile soil, aptly compounded of different substances, sufficiently loose in its aggregation, and capable of retaining the necessary moisture. Soil arising from the disintegration of granite is unfavourable to vegetation only, where the rock abounds much in quartz, and where the superfluous water cannot run off, and so gives rise to marshes, which produce only vegetables of inferior quality; of which we have examples in the granite districts of Aberdeen. In such places as these, peat is easily generated, which, although of great use, is yet much less advantageous than wood. *Syenite*, which abounds much in hornblende, is inferior to granite, with respect to the production of fertile soil; and primitive *greenstone*, which resists disintegration and decomposition in the highest degree, occupies the last place in this class. In the series of slaty crystalline rocks, *mica-slate* is next to gneiss: but on account of the small proportion of felspar which enters into its composition, it does not afford so productive a soil.

In the sixth class may be placed the slaty rocks, whether simple, or intimately compounded, which do not readily undergo chemical decomposition, but which easily separate at their natural fissures, and are mechanically resolved into an earthy mass, forming a paste with water,—circumstances which are observed chiefly in *clay-slate*, a rock of much importance in the formation of productive soil, usually passing into a clayey sort of earth.

To the seventh class belong the conglomerated rocks, whose parts indeed undergo very little, if any, chemical change, but are easily separated by mechanical means, and are thus converted into a gravelly, sandy, or earthy mass. Of this kind are *greywacke*, *old red sandstone*, and sandstones of various kinds. Much diversity is exhibited by these rocks, with regard to the facility with which they undergo disintegration, as well as the nature of the soil arising from them; circumstances which chiefly depend upon the nature of the cement, and its relation to the parts cemented. The disintegration of these rocks is the more easily effected that the cement is abundant, and less intimately connected with the other parts, that is, the more they depart from a crystalline nature ; on which account greywacke is less easily converted into soil, than the common varieties of sandstone. By the decomposition of greywacke, a loose and fertile soil is formed, containing particles of quartz and clay in due proportion ; on the other hand, by the decomposition of red sandstone, a soil is frequently produced, abounding in argillaceous particles impregnated with iron, and therefore stiff and cold. The *variegated sandstone*, with a marly cement, not unfrequently affords a pretty fertile soil; the *quadersandstein*, on the contrary, commonly presents a sandy and arid soil.

Lastly, in the eighth class we shall place those rocks, whether simple or intimately compounded, whose nature is so loose, or whose parts are so separated, that they fall with great facility into an earthy mass, and are also in part mechanically reduced by water. To this class belong the different varieties of *marl*, *slate-clay*, *basaltic* and *volcanic tuffa*. These rocks, many of which are extensively diffused, are of much importance in the formation of productive soil, although the quality of the earth produced by them varies much, according to their different natures. Slate-clay affords an argillaceous soil; in earth produced by the decomposition of marl, the clay is diminished in proportion to the greater abundance of the calcareous or sandy parts; while a mixed and very fertile soil is usually generated from basaltic and volcanic tufas.

The various relations which exist in the stratification and position of rocks, have much influence in producing a diversity in the soil formed immediately from their decomposition. This diversity cannot be so great when different rocks of various ages occur in a determinate order in horizontal strata; in which case, the uppermost bed may exhibit a great extent of surface of the same nature. When, on the other hand, strata of rocks of different natures, forms, and dimensions, placed at different angles of inclination, and in different directions, appear at the surface, it will easily be understood how it may happen that the soil produced by their decomposition may occur of very different qualities, in places not very distant from each other. The manner in which the soil is influenced by a difference in the arrangement and position of the strata, will become evident, on comparing districts in which one particular sort of rock lies beneath the surface in horizontal strata, with others in which the solid substratum is composed of various rocks differing in their inclination towards the horizon. In districts of the former kind, the qualities of the soil vary in general but little; in such as are of the latter kind, on the contrary, they are often found extremely different. The great diversity of soil seen in England, as well as in Germany, may, in fact, be partly explained by the circumstance, that, in those countries, the nature and position of the strata vary every where. On the other hand, the great similarity which pervades the soil of Southern Russia, is without doubt produced by a uniformity in the position and inclination of the limestone which lies immediately under the soil.

The nature of the principal mass of the strata usually exerts a great degree of influence over the qualities of the soil. When the solid substratum is sandstone, its effect upon the soil is, in general, as evidently seen, though not perhaps in an equal degree, as when it is marl. Exceptions, however, to this rule sometimes occur; as, for instance, when the principal mass of a rock which resists disintegration in a high degree contains beds that are easily reduced to earth. This is the case with the shell limestone (muschelkalkstein) of Germany, the mountains of which are not unfrequently covered with a clayey soil, which has not been produced by the decomposition of the principal strata themselves, but by that of the slate-clay and argillaceous marl alternating with them.

Hitherto we have considered untransported soil, or that produced from the disintegration or decomposition of the subjacent rocks in the places where it occurs; we have now to examine the relations which exist between the subjacent rock, and the *transported soil* lying upon it. The nature of the rock does not indeed influence, excepting in a more remote degree, the transported soil, which has been carried to a greater or less distance from the places of its production, by the agency of moving powers, and again deposited of various forms and compositions. However, it may often be plainly seen, that the materials of this soil have been derived from particular rocks, and that these rocks have exerted some degree of influence over the formation and distribution of the transported soil. The examination of these relations is of great importance, because it is with secondary or transported soil that agriculture is principally concerned. The varieties of transported soil depend chiefly upon three circumstances: 1*st*, The nature of the rocks from which they are derived; 2*dly*, The quality and effect of the moving powers; 3*dly*, The changes which they may have undergone after their formation.

The origin of the materials which enter into the composition of transported soil, has been already considered. From their difference may be easily explained why soil generated from the debris of primitive crystalline rocks has different qualities from soil which has been derived from strata of sandstone or marl.

The principal powers which contribute to the transportation of soil, are, The weight of loose masses, ice, and water. The weight of loose masses is a cause of transportation which we frequently see in operation. By it the huge cones of debris at the base and upon the declivities of precipices and mountains, are gradually carried off toward the bottom of the valleys; a phenomenon which can scarcely any where be better seen than in the valleys of the Alps, where mountains sometimes occur evidently consisting of debris, and clothed with trees and shrubs, or covered with pastures, the masses of which are gradually moved, as upon inclined planes, by the action of the water which percolates through them.

Ice effects the transportation of rocks and debris, with a power which nothing can resist. This is no where more conspicuous than among the glaciers of the Alps, by the falling of which great heaps of stones and rubbish are produced. The transportation of large stones by means of ice may also be seen in our mountain torrents in winter. Huge masses of stone, scattered over the plains of the north of Germany and the islands of Denmark, and often very prejudicial to agriculture, whose northern origin appears to be established, may have been carried by the same powerful agent from Finland, Sweden and Norway, into those countries, at a time when the plains of northern Germany, with the other flat districts along the shores of the Baltic, were still covered by the waves of the ocean.

In the formation of transported soil, water usually exerts a great degree of power. By means of it, not only are vast masses transported to the greatest distances, but their parts are at the same time crumbled down and mingled together. To these operations are to be attributed the various terminations of different soils at horizontal distances, as well as the different alternations of their strata at vertical ones. The power of water in the formation of transported soil varies, not only according to the different inclinations of its channel, but also in regard to the form, size, and weight of the parts carried off by it; for which reason, in the formation of such soils, the same phenomena take place on a large scale, that we see on a smaller, in performing the operations of breaking and washing the ores of metals. For the same reason that, in these processes, the larger particles subside, while the smaller are propelled, from which again the heavier particles of ore are sooner deposited than the lighter; in plains in the vicinity of a mountain, covered with transported soil, stones and debris are usually seen first, then earth, clay, and sand mixed together, and farther on, finer sand, with strata of clay.

Transported or secondary soil, produced by water, according to the mode of its formation, is divided into four classes, viz.—1. Soil of Valleys; 2. River Soil; 3. Lake Soil; 4. Marine Soil.

1. *Soil of Valleys.*—It is washed down by rain and snow water, and partly also produced by rivulets, which carry off the loose parts from the declivities of mountains to the plains. The nature of this soil in general clearly shews the nearness of its origin. Its depth is always greatest in the bottom of the valley, and gradually diminishes toward the declivities of the mountains. The curvature of the different strata is usually accommodated to the irregularity of its external form, so that when a

section is made of them, they exhibit a series of parallel curved lines.

2. *River Soil*, or the soil found in the beds and banks of rivers, and which is produced by the continual propelling power of large rivers. To this class belong two different kinds; 1*st*, Soil containing pebbles of various sizes, produced by the power of torrents in the vicinity of mountains; and, 2*d*, Earth or mud, deposited in the beds of rivers, in places at a distance from mountains. A peculiarity of river soil in general is, that it is much extended in length, while its breadth is comparatively but small. The different layers have neither so much irregularity as in the preceding kind, nor are they so precise in arrangement as in the following.

3. *Lake Soil*, deposited at the bottom of still water. To this class is to be referred the soil in the bottoms of valleys, which had formerly been lakes, either separate or connected with rivers. The horizontal dimensions of this kind of soil are often more or less equal. Sometimes, indeed, the length is greater than the breadth; not, however, in the same degree as in soil deposited in the bed of rivers. The surface is usually plane, and the different strata alternate in a parallel manner.

4. *Marine Soil*, that is to say, the mud of the ancient ocean. It is the greatest of all in its extent, both in a horizontal and a vertical direction. Its surface is more or less undulated, very seldom even. Its masses are both very thick and very uniform in composition. Different and alternating strata, however, do occur, whose forms and dimensions are usually more or less regular, and which are not unfrequently undulated.

Soil, after being formed, is acted upon by natural powers in various ways. The atmosphere is perpetually modifying it; rivers, waves, and winds, act here and there upon its surface, and alter its external form; water introduces into it the substances which it holds in solution. The different constituent parts of soil act upon each other chemically, and in this manner new decompositions and mixtures are produced; and this chemical change is increased by the action of vegetables, as well as of bodies deriving their origin from both organic kingdoms.

From what has been said of the relations existing between the masses of which the solid crust of the globe is composed, and the loose earth or soil by which it is covered, it appears evident enough (Hausmann concludes) that they have great influence over its formation and nature, and therefore upon the more perfect vegetables, and especially those which are the objects of cultivation; and that although the fertility of the soil is much increased by these vegetables themselves, yet the first foundation of their vigour is derived from the disintegration and decomposition of rocks. If this be correct, the constitution of the solid crust of the earth has a much more extended influence. For, by preparing a habitation for the greater and most important parts of plants, it also exerts a high degree of influence upon the animals which derive their sustenance from them, and, at the same time, affords the means of subsistence to man *.

---

* Those who feel disposed to examine the connection of Geology and Agriculture, will find many additional details and views given in Hausmann's work, of which the above may be considered in some degree as a condensed view.

NOTE.

ACCOUNT OF THE IRISH ELK, FOSSIL ELEPHANT OR MAMMOTH, AND THE MASTODON.

As the Irish Elk, the Fossil Elephant or Mammoth, and the Mastodon, are among the most remarkable of the fossil and extinct species of quadrupeds mentioned in the preceding pages of this work, we, with the view of farther gratifying the curiosity of our readers, now lay before them the following additional details from the writings of Cuvier, Goldfuss, and others.

1. *Fossil Elk of Ireland*, Cervus megaceros *.

(Noticed at p. 286.*)*

One of the most magnificent of the bisulcated animals met with in a fossil state in the British Islands is the Elk of Ireland, the *Cervus megaceros*. Bones and horns of vast size of this species are almost daily dug out of the bogs and marl pits of Ireland. Similar remains have been met with in alluvial strata in Britain, and also in the Isle of Man.

"So frequently do these remains," Mr Hart remarks, "occur in most parts of Ireland, that there are very few of the peasantry who are not, either from personal observation or report, acquainted with them by the familiar name of the horns of "the old deer." Indeed in some parts of the country they have been found so often, that far from being regarded as objects of any extraordinary interest, they have been either thrown aside as lumber, or applied to the commonest economical uses *.

---

* John Hart, Esq. Member of the Royal College of Surgeons in Ireland, some time ago sent to me a copy of a very interesting tract entitled "A Description of the Skeleton of the Fossil Deer of Ireland, *Cervus megaceros*; drawn up at the instance of the Committee of Natural Philosophy of the Royal Dublin Society." The details in the text are extracted from Mr Hart's memoir, and the engraving of the Elk is copied from Mr Hart's lithographic delineation.

"I have made diligent but fruitless search for an account of the particular time when any of these remains were first discovered. As they generally occur in marl, it is most likely that they did not begin to attract attention until the advanced state of agriculture had created an increased demand for that mineral as a manure. We can very easily imagine the astonishment which the appearance of horns so large, and of such strange form, must have excited in the minds of those who discovered them for the first time, and how readily they obtained a place in the hall of some adjoining mansion, where they were deposited as an ornament of great curiosity, from the contrast which they formed with the horns of the species of deer known at present. In this way we may account for the preservation of so many specimens as are found in the possession of the gentry in different parts of this country.

"Very lately an entire skeleton of the Irish Elk was dug up in that country. The following statement of the cir-

---

* In a Report which Mr Hart made to the Committee of Natural Philosophy of the Royal Dublin Society, and which was printed in their Proceedings of July 8. 1824, he alluded to an instance of a pair of these horns having been used as a field gate near Tipperary. Since that he has learned that a pair had been in use for a similar purpose near Newcastle, county of Wicklow, until they were decomposed by the action of the weather. There is also a specimen in Charlemont House, the town residence of the Earl of Charlemont, which is said to have been used for some time as a temporary bridge across a rivulet in the county of Tyrone.

cumstances under which the bones were found, with their geological position, was laid before the Dublin Society, in a letter from Archdean Maunsell to the Right Hon. George Knox.

"*Middleton Lodge*, *March* 8. 1825.

"MY DEAR SIR,

"I deferred replying to your letter of the 1st, as it was my intention to proceed to Limerick in a few days, and I was anxious to look over some notes I had taken, and which I left there, of the circumstances connected with the discovery of the fossil remains which the Royal Dublin Society have received. As I have, however, been obliged to postpone my departure for several days, I can no longer defer offering my best thanks for the kind manner in which you have received the conjectures which I formed upon a subject to which my attention was directed, by having fortunately been present before the bones were disturbed from the situation in which they had lain during a period which I apprehend it would not be easy to define. I am sensible that any consideration which may have been attached to my observations should be attributed to the interest which the subject itself is calculated to excite, rather than to any ability of mine to do it justice. The opinion which I took the liberty of communicating to you was formed after some consideration, and although I had not the most remote idea of its being worthy of any attention, I can have no objection to your making any use of it which you may conceive expedient. There is, I conceive, much interesting material for speculation, resulting from the discovery of these fossil remains, and the first that naturally occurs is the manner in which the animals were destroyed, and the bones so singularly preserved. I stated, in the hasty sketch which I gave you of my theory upon this point, that I apprehended they must have been destroyed by some overwhelming deluge, that they were probably drowned upon the hills where they had taken refuge, as the waters rose, and that, as they subsided, they were drawn from thence into the valley in which they were found; that the agitation of the waters had occasioned such a dispersion of the bones, when the ligaments dissolved, as would account for their having been scattered in the way in which they were found, and that the deposite of shell marl, with which I supposed the water to have been turbid, had so completely protected them from atmospheric influence as to prevent their subsequent decomposition. To enable you to form some estimate of the reasonableness of this supposition, it is necessary that I should endeavour to explain the situation, &c. of the valley and the adjoining hills. The valley in which the remains were found contains about twenty plantation acres, and the soil consists of a stratum of peat about a foot thick, immediately under this a stratum of shell-marl, varying from 1½ to 2½ feet in thickness; in this many of the shells retain their original colour and figure, and are not marine; under the marl there is a bed of light blue clay; through this one of my workmen drove an iron rod, in several places, twelve feet deep, without meeting opposition. Most of the bones and heads, eight in number, were found in the marl; many of them, however, appeared to rest on the clay, and to be merely covered by the marl. The remains were disposed in such a manner as to prevent the possibility of ascertaining the exact component parts of each skeleton; in some places portions were found removed many yards from others, and in no instance were two bones found lying close to each other. Their position also was singular; in one place two heads were found, with the antlers entwined in each other, and immediately under them a large blade-bone; in another, a very large head was discovered, and although a most diligent search was made, no part of the skeleton found; within some hundred yards, in another, the jaw-bones were found, and not the head. The conclusion which, I conceive, may fairly be deduced from such a position of the various parts of the animals is, that there must have been some powerful agent employed in dispersing them after their death; and as I consider it impossible that their own gravity could have been sufficient to sink them through the various strata, I conceive these must have originated subsequently to the dispersion of the bones. I also think, that, if they had been exposed for any time to atmospheric influence, they never could have been preserved in their present extraordinary perfection.

"The hills immediately adjoining this valley are composed of limestone, with a covering of rich mould of various degrees of thickness. One of them, whose base is about thirty acres, rises directly from the edge of the valley, with sides very precipitous, and in one place perfectly perpendicular, of naked limestone. In every part of this hill the superficies comprises as much stone as mould; on the side nearly opposite, the hill is equally high, but the sides not so steep, and the covering of mould thicker; on the other sides the ground only rises in some degree (twenty or thirty feet perhaps), and consists of a thin mould, and immediately under a *very hard* limestone gravel. Indeed, except where nestone forms the substratum, this is the character of l the soil in the vicinity except the Corkasses, which e evidently alluvial. I am fully aware, that, assuming e destruction of the animals to have been occasioned y a flood, they would naturally have retreated from e water to the hills, and that, as they probably met eir fate there, their remains should have been discoered on the summit of the hills, and not in the valley, rticularly as one of them is perfectly flat on the top, hich contains six or seven acres. I apprehend that e remains of many of them were deposited on the ps of the hills; but as they have *now* only a slight vering of mould, not sufficient to cover a small dog, ey were formerly perfectly bare; and as they were us devoid of the means of protecting the remains om the atmosphere, whatever was left there soon beme decomposed, and resolved into portions of the ould, which is now to be found on the hills. This reark I conceive also to be applicable to the soil with e substratum of limestone gravel, which affords quite s little material for preserving the bones as the hills o.

"It is material that I should observe, that of eight eads which we found, none were without antlers; the riety in character also was such as to induce me to nagine, that possibly the females were not devoid of hese appendages. Unfortunately, however, from the ifficulty of raising them, being saturated with water, nd as soft as wet brown paper, only three were at all erfect.

Having now disposed of these antediluvians, a quesion naturally arises, how it happens that the fossil renains of no other animals were found, when the same fate probably overwhelmed every existing creature? Could deer have been the only living beings at that period? Was Ireland part of a great continent when this catastrophe occurred, and were these unfortunates the first emigrants to our Isle from that great centre from whence the globe was supplied with occupants, and did they perish before other animals less influenced by enterprise, and less endowed with physical strength, could have followed their example? These problems I confess myself unable to solve, and shall not presume to obtrude my many reveries upon this and other points, which have originated in the discovery of a few bones, upon those who I know are so much better competent to form a sound opinion. I shall, I hope, be able to send the antlers, which are very fine, on the 15th of this month.

"If you have a desire to make any use of this letter, I can only say I have no objection. I remain, dear Sir, with feelings of great respect,

"Yours most truly,

"WILLIAM W. MAUNSELL."

Of this skeleton, the most perfect hitherto found, the following interesting description is given by Mr Hart, in his memoir.

"This magnificent skeleton is perfect in every single bone of the framework which contributes to form a part of its general outline: the spine, the chest, the pelvis, and the extremities, are all complete in this respect; and, when surmounted by the head, and beautifully expanded antlers, which extend out to a distance of nearly six feet on either side, forms a splendid display of the reliques of the former grandeur of the animal kingdom, and carries back the imagination to a period when whole herds of this noble animal wandered at large over the face of the country.

To proceed with a description of the several parts of this specimen in detail, I shall commence with the horns, which give the animal its chief characteristic feature.

The horns.—That the description of these may be the more intelligible, I will first explain the terms which I mean to apply to their several parts. Each horn consists of the socket or root, the burr or coronary circle, the beam or shaft, the palm and the antlers.

The socket or root is the part of the horn which grows out of the frontal bone, and which is never shed; it is smooth, of a brown colour, an inch and half in length, and eleven inches three quarters in circumference; in the animal's lifetime it was covered by the skin. The coronary or bead-like circle, or burr, is a ring of small, hard, whitish prominences, resembling a string of pearls, which encircles the junction of the socket with the part of the horn which falls annually from the heads of all deer.

The beam or shaft extends outwards, with a curvature whose concavity looks downwards, and backwards. This part is nearly cylindrical at its root, and its length equals about one-fourth of that of the whole horn; its outer end is spread out and flattened on its upper surface, and is continuous with the

Palm, which expands outwards in a fan-like form, the outer extremity of which measures two feet ten inches across, being its broadest part. Where the beam joins the palm the horn undergoes a kind of twist, the effect of which on the palm is, to place its edges above and below, and its surfaces anterior and posterior; the anterior surface is convex, and looks outwards; the posterior is concave, and its surface looks towards that of the opposite palm. Such is the position of the horns, when the head is so placed that the zygomatic arch is parallel to the horizon, as it would be during progression, or whilst the animal stands in an easy posture.

The antlers are the long pointed processes which project from the horns, two of which grow from the beam anteriorly; the first comes off immediately from the root, and is directed downwards, overhanging the orbit; this is called the brow antler, which, in this specimen, is divided into two points at its extremity *.

The other antler, which comes off from the beam, we may call the sur-antler: in this specimen it consists of a broad plate or palm, concave on its upper surface, horizontal in its direction, and forked into two points anteriorly,—an appearance which I have not observed in any other specimen of upwards of forty which I have seen, nor do I find it marked in any of the plates of those bones extant.

There is one antler given off posteriorly from the junction of the beam with the palm: it runs directly backwards parallel to the corresponding one of the opposite horn. The inferior edge of the palm beyond this runs

---

* I have seen this antler divided into three points in two specimens, one at the Earl of Besborough's, county Kilkenny (which measured eight feet four inches between the tips), the other in the hall of the Museum of Trinity College: it is single in the greater number of specimens, as in those which Cuvier describes.

outwards and backwards: it is obtuse and thick, and its length is two feet six inches. From the anterior and external borders of each palm there come off six long pointed antlers. None of these are designated by any particular name. The number of the antlers of both sides taken together is twenty-two.

The surface of the horns is of a lightish colour, resembling that of the marl in which they were found; they are rough, and marked with several arborescent grooves, where the ramifications of the arteries by which they had been nourished during their growing state were lodged. The horns, with the head attached, weighed eighty-seven pounds avoirdupois. The distance between their extreme tips in a right line is nine feet two inches.

Head.—The forehead is marked by a raised ridge extended between the roots of the horns; anterior to this, between the orbits and the root of the nose, the skull is flat; there is a depression on each side in front of the root of the horn and over the orbit, capable of lodging the last joint of the thumb, at the bottom of which is the superciliary hole, large enough to give passage to an artery proportioned to the size of the horns. Inferior to the orbit we have the lachrymatory fossa, and the opening left by the deficiency of bone common to all deer, and remarkable for being smaller in this than in any other species.

Below the orbits the skull grows suddenly narrower, and the upper parts of the nasal bones become contracted by a depression on either side, at the lower part of which is the infra-orbitar hole. The opening of the nares is oval, being five inches long by three broad, the greatest breadth being in the centre. From the roots of the horns to the occipital spine measures three inches and an half; the occiput descends at a right angle with this, being three inches deep to the foramen magnum: the greatest breadth of the occiput is eight inches. The temporal fossæ approach to within two inches of each other behind the horns.

Teeth.—They do not differ from those of animals of the ruminating class. The incisors were not found, having dropped out; there is no mark of canine teeth; the molares are not much worn down, and are twenty-four in number.

The skeleton measures, from the end of the nose to the tip of the tail, ten feet ten inches. The spine consists of twenty-six vertebræ, viz. seven cervical, thirteen dorsal, and six lumbar. The size of the cervical vertebræ greatly exceeds that of the other classes, and the spines of the dorsal rise to a foot in height. The necessity of these bones being so marked is obvious, considering the strong cervical ligament, and powerful muscles, required for supporting and moving a head which, at a moderate calculation, must have sustained a weight of three quarters of a hundred of solid bony matter.

The extremities are in proportion to the different parts of the trunk, and present a conformation favourable to a combination of great strength with fleetness.

It is not the least remarkable circumstance connected with these bones, that they are in such a high state of preservation as to present all the lines and impressions of the parts which had been attached to them in the recent state. Indeed, if we examine them as compared with the bones of an animal from which all the softer parts have been separated by maceration, the only perceptible differences in their physical properties are, that they are a little heavier, a degree harder, that their surface is brown, and that they all, with the exception of the horns, present a polished appearance, which is owing to the periosteum having been preserved, and still remaining to cover them, as was discovered when they were chemically examined.

The existence of fat or adipocire in the shaft of one of the bones mentioned by Archdeacon Maunsell, and which I saw in his possession, is a thing for which it is extremely difficult to account, as it occurred but in one solitary instance, and it did not appear that this bone was at all differently circumstanced from the rest. Those which I had an opportunity of examining, by boring holes in them, were hollow, and contained, for the most part, only a small quantity of black animal earth.

Mr Stokes found, in a rib of this animal,

Animal matter, - - - - - -	42.87
Phosphates with some Fluates, - -	43.45
Carb. Lime, - - - - -	9.14
Oxides, - - - - - -	1.02
Silica, - - - - - -	1.14
Water and loss, - - - - -	2.38
	100.00

Dr Apjohn of Dublin made the following observations with regard to the animal matter in the bones:

"The bone was subjected for two days to the action of dilute muriatic acid. When examined at the end of this period, it had become as flexible as a recent bone submitted to the action of the same solvent. The periosteum was in some parts puffed out by carbonic acid gas, disengaged from the bone, and appeared to be in a state of perfect soundness.

"To a portion of the solution of the bone in the muriatic acid some infusion of galls was added, which caused a copious precipitate of a dun colour. This proved to be tannate of gelatine, mixed with a small portion of the tannate and gallate of iron.

"The cartilage and gelatine, therefore, so far from being destroyed, had not been perceptibly altered by time."

Until Baron Cuvier published his account of these remains *, they were generally believed to have belonged to the same species as the moose deer or elk of North America, an opinion which appears to have been first advanced by Dr Thomas Molyneux in 1697 †, and which depends principally on the exaggerated description of that animal given by Josselyn in his account of two voyages to New England, published in 1674, in which he states that it is sometimes twelve feet high, with horns of two fathoms wide! This was the more readily believed by the learned Doctor, as it tended to confirm him in a favourite theory which he seems to have entertained, that Ireland had once been joined to the New Continent.

---

* Vide Annales du Museum d'Histoire Naturelle, tome xii. et Ossemens Fossiles, tome iv.

† Philosophical Transactions, vol. xix.

But the assertions of Josselyn regarding the size of the American moose have not been confirmed by the testimony of later travellers, from whose observations it is now clearly ascertained that the only large species of deer inhabiting the northern parts of America are the wapiti or Canadian stag *(Cervus canadensis)*, the rein-deer *(C. Tarandus)*, and the moose or elk *(C. Alces)*.

The peculiar branching of the brow antlers of the rein-deer, and the rounded horns of the wapiti [*], are characters sufficient to prevent us confounding either of these animals with the fossil species.

The palmate form of the horns of the elk gave greater probability to the opinion of its specific identity with the fossil animal.

A little attention, however, to a few circumstances, will shew a most marked difference between them.

First, as to size, the difference is very remarkable, it not being uncommon to find the fossil horns ten feet between the extreme tips [†], while the largest elk's horns never measure four feet. This measurement in a pair in the Museum of the Royal Dublin Society, is three feet seven inches: the largest pair seen by Pennant in the house of the Hudson's Bay Company, measured thirty-four inches [‡].

The horn of the elk has two palms, a lesser one which grows forward from the front of the beam, where the principal palm begins to expand. This is called brow antler by Cuvier, but it corresponds in situation rather to the sur-antler, there being, properly speaking, no brow antler attached to the root of the beam. The elk has no posterior antler similar to that of the fossil animal, nor does its beam take a similar arched direction, but runs more directly outwards.

---

[*] A fine pair of this species, male and female, were exhibited by Mr Bullock in this city a few summers ago. They did not answer to any description of Pennant or of Dr Shaw, but had the characters of C. canadensis as given by Cuvier.

[†] Dr Percy, Bishop of Drumore, describes a pair which measured fourteen feet by the skull. Archæologia Brit. v. vii.

[‡] Pennant's Zoology, vol. i.

Cuvier remarks, that the palm of the fossil horn increases in breadth as it extends outwardly, while that of the elk is broadest next the beam.

The palm of the elk's horn is directed more backwards, while the fossil one extends more in the lateral direction. The antlers of the elk are shorter and more numerous than those of the fossil animals.

As the horns of the fossil animal exceed in size those of the elk, so, on the contrary, does the skull of the latter exceed in size that of the former; the largest heads of the fossil species not exceeding one foot nine inches in length, while the head of the elk is frequently two feet. The fossil head is broader in proportion; its length being to its breadth as two to one; in the elk they are as three to one, according to Parkinson.* The breadth of the skull between the roots of the horns is but four inches in the fossil skulls; in that of the elk in the Society's Museum it is 6½ inches.

Cuvier thinks it probable that the females of the fossil species had horns†, an opinion to which I am very much disposed to subscribe, from having observed that these parts present differences in size and strength, which appear not to be dependent on differences of age. For instance, the teeth of the specimen in Trinity College are much more worn down, and the sutures of the skull are more effaced than in the specimen described in this paper; yet the horns of the latter are much more concave, and more expanded, than those of the former; and on comparing a single horn of each of these specimens together, that belonging to the Society exceeds the other by nearly a sixth in the length, and little less than a third in the breadth; it is not, therefore, unlikely that the animal whose horns were larger and more curved was a male. Something similar to this is observed in the rein-deer, both sexes of which have horns, but with this difference, that they are smaller and less branched in the female. Hence we find that this animal possessed characters of its own sufficient to prove it of a species as distinct from the moose or elk as this latter species is from the rein-deer or any other. Therefore, it is improper to retain the name of elk or moose deer any longer: perhaps it might be better called the *Cervus megaceros*, a name merely expressive of the great size of its horns

---

* Organic Remains, vol. iii. † Ossemens Fossiles, tom. iv.

That this animal shed its head furniture periodically, is proved by the occasional occurrence of detached horns having the smooth convex surface below the burr, similar to what is observed on the cast horns of all deer. Specimens of this are to be seen in the Museum of Trinity College, and I possess one myself, of which I have had a drawing made. As every other species of deer shed their horns annually, there is no reason for supposing that that process occurred at longer intervals in this.

It is a popular opinion with the Indians that the elk is subject to epilepsy, with which he is frequently seized when pursued, and thus rendered an easy prey to the hunters. Many naturalists affect to disbelieve this account, without, however, assigning any sufficient reason. But if it be considered, that, during the growth of the horns, there must be a great increased determination of blood to those parts, which are supplied by the frontal artery, a branch from the internal carotid, it is quite conformable to well established pathological principles, to suppose, that, after the horns are perfected, and have ceased to receive any more blood, that fluid may be determined to those internal branches of the carotid which supply the brain, and establish a predisposition to such derangements of its circulation as would produce epilepsy, or even apoplexy: if such an effect were produced in consequence of the size of the horns in the elk, it is reasonable to suppose that it prevailed in a greater degree in the fossil animal whose horns were so much larger.

What could have been the use of these immense horns? It is quite evident that they would prevent the animal making any progress through a thickly wooded country, and that the long, tapering, pointed antlers were totally unfit for lopping off the branches of trees, a use to which the elk sometimes applies his horns *, and for which they seem well calculated, by having their antlers short and strong, and set along the edge of the palm, somewhat resembling the teeth of a saw in their

---

* The elk, when pursued in the forests of North America, breaks off branches of trees as thick as a man's thigh.

arrangement. It would rather appear, then, that they were given the animal as weapons for its protection, a purpose for which they seem to have been admirably designed; for their lateral expansion is such, that should occasion require the animal to use them in his defence, their extreme tips would easily reach beyond the remotest parts of his body; and if we consider the powerful muscles for moving the head, whose attachments occupied the extensive surfaces of the cervical vertebræ, with the length of the lever afforded by the horns themselves, we can easily conceive how he could wield them with a force and velocity which would deal destruction to any enemy having the hardihood to venture within their range.

From the formidable appearance of these horns, then, we must suppose that their possessor was obnoxious to the aggressions of some carnivorous animals of ferocious habits; and such we know to have abounded in Ireland, as the wolf, and the celebrated Irish wolf dog. Nor would it be surprising if limestone caves should be discovered in this country, containing the remains of beasts of prey and their victims, similar to the hyænas' dens of Kirkdale, and other places, respecting which such interesting researches have been lately laid before the public by the geologists of this country and the Continent.

The absence of all record, or even tradition, respecting this animal *, naturally leads one to inquire whe-

---

* It is evidently not the animal mentioned by Julius Cæsar, under the name of Alces; vide Comment. de Bello Gallico, vi. cap. x. ; nor is it the Alces of Pliny.

ther man inhabited this country during its existence? I think there is presumptive evidence in the affirmative of this question, afforded by the following circumstances. A head of this animal described by Professor Goldfuss of Bonn, was discovered in Germany in the same drain with several urns and stone hatchets; and in the 7th volume of the Archæologia Britannica, is a letter of the Countess of Moira, giving an account of a human body found in gravel, under eleven feet of peat soaked in the bog water: it was in good preservation, and completely clothed in antique garments of hair, which her ladyship thinks might have been that of our fossil animal. But more conclusive evidence on this question is derived from the appearance exhibited by a rib, presented by Archdeacon Maunsell to the Royal Dublin Society, in which I discovered an oval opening near its lower edge, the long diameter of which is parallel to the length of the rib, its margin is depressed on the outer, and raised on the inner surface, round which there is an irregular effusion of callus. This opening had been evidently produced by a sharp pointed instrument, which did not penetrate so deep as to cause the animal's death, but which remained fixed in the opening for some length of time afterward; in fact it was such an effect as would be produced by the head of an arrow remaining in a wound after the shaft was broken off *.

---

* I am well aware of the occasional existence of holes in the ribs, a few instances of which I have seen in the human subject: but they differ essentially in character from the opening here described, as they occupy the centre of the rib, mostly in its sternal extremity, and have their margin depressed on both sides.

It is not improbable, therefore, that the chace of this gigantic animal once supplied the inhabitants of this country with food and clothing.

As to the causes which led to the extinction of this animal, whether it was suddenly destroyed by the deluge, or by some other great catastrophe of nature, or whether it was ultimately exterminated by the continued and successful persecution of its pursuers, as has nearly been the case with the red deer within the recollection of many of the present generation, I profess myself unable to form any decided opinion, owing to the limited number of facts as yet collected on the subject. On some future occasion I may, perhaps, be induced to revert to so interesting a topic, should I have opportunities of discovering any thing worthy of communication.

The following Table exhibits a comparative view of the measurements of different parts of the skeletons of the Cervus Megaceros in the Museum of the Royal Dublin Society, and in the Royal Museum of the University of Edinburgh, with some parts of the Moose. The measurements of the Edinburgh specimen are taken from Professor Jameson's memoir on *organic remains*, in the Supplement to the Encyclopedia Britannica.

	R. D. Soc.		U. of Edin.		Moose	
	Ft.	In.	Ft.	In.	Ft.	In.
Length of the head, ...	1	8½	1	8¼		
Breadth of the skull between the orbits, ...	0	10½	0	9		
Do. of skull at the occiput,	0	8				
Diameter of the orbit, ...	0	2⅝	0	2½		
Distance between infra orbitar holes across the skull,	0	7				
Length of alveolar processes of the upper jaw, ...	0	6	0	6		
Length of lower jaw, ...	1	5½	0	3½		
Diam. of foramen magnum,	0	2				
HORNS.						
Distance between the extreme tips, measured by the skull, ...	11	10				
Ditto, in a straight line across, ...	9	2	6	8	3	7
Length of each horn, ...	5	9	5	1		
Greatest breadth of the palm,	2	10				
Length of the beam, ...	1	9			0	6½
Ditto of brow antler, ...	0	8¾				
Ditto of sur-antler, ...	1	4				
Circumference of the beam at root of brow antler,	1	0¾			0	7½

	R. D. Soc. Ft.	R. D. Soc. In.	U. of Edin. Ft.	U. of Edin. In.	Moose Ft.	Moose In.
BODY.						
Length of spine, ...	10	10	9	8		
Ditto of sternum, .. —	2	4				
Height to the upper extremity of the dorsal spines,	6	6				
Ditto to the highest point of the tip of the horn, ...	10	4				
EXTREMITIES.						
Greatest length of the scapula, ...	1	6½				
Ditto breadth at the base,	0	10¾				
Ditto depth of its spine, ...	0	2¾				
Length of the humerus, ...	1	4	1	3½		
Ditto of ulna and radius,	1	8	1	6		
Ditto of carpus, ...	0	2¾	0	2		
Circumference of do.	0	9½				
Length of metacarpus, ...	1	0½	1	0½		
Length of phalanges, ...	0	7	0	6½		
From anterior superior spine of one ileum to that of the other, ...	1	4½	1	6½		
From anterior superior spine to the tuber ischii, ...	1	8	1	9½		
Greatest diameter of foramen ovale, ...	0	4	0	3		
Least do. of do.	0	2¾	0	2¼		
Length of the femur, ...	1	6½	1	5½		
Ditto of tibia, ...	1	6	1	6		
Length of the tarsus, including the os calcis, ...	0	8				
Ditto of the metatarsus, ...	1	1¾	1	1¾		

2. *Account of the Two Living Species of Elephant, and of the Extinct Species of Elephant, or Mammoth.*

1. Elephas africanus.—*The Elephant with rounded skull, large ears, grinders, having rhomboidal-shaped marks on their crown, which we call the African Elephant* (*Elephas Africanus*), is a quadruped which has hitherto been found only inhabiting Africa. There can be no doubt that it is this species which lives at the Cape, at Senegal, and in Guinea; there is reason to believe that it also occurs at Mosambique; but it is not certain that individuals of the following species do not occur in this part of Africa. A sufficient number of individuals have not been figured or compared, to know if this species presents remarkable varieties. It is it that produces the largest tusks. Both sexes are equally furnished with tusks, at least at Senegal. *The natural number of the hoofs is four before, and three behind.* The ear is very large, and covers the shoulder. The skin is of a deep and uniform brown. This species has not been domesticated in modern times. It appears, however, to have been tamed by the ancients, who attributed to it less power and courage in that state than to the following species; but their observations do not appear to have been confirmed, at least in so far as refers to magnitude. Its natural manners are not perfectly known; yet judging of them by the notices of travellers, they appear to resemble in every thing essential those of the following species.

2. Elephas indicus.—*The Elephant with elongated skull, concave forehead, small ears, grinders marked with undulating bands*, which we call the *Indian Elephant* (*Elephas Indicus*), is a quadruped which has only been observed with certainty beyond the Indus. It extends from both sides of the Ganges to the Eastern Sea and the south of China. They are also found in the Islands of the Indian Sea, in Ceylon, Java, Borneo, Sumatra, &c. There is still no authentic proof that it exists in any part of Africa, although neither is the contrary absolutely proved. The inhabitants of India having from time immemorial been in the habit of taking this species and taming it, it has been much better observed than the other. Varieties have been remarked as to size, lightness of form, the length and direction of the tusks, and the colours of the skin. The females and some of the males have tusks which are always small and straight. The tusks of the other males never attain so great a length as in the African species *. *The natural number of the hoofs is five before and four behind.* The ear is small, frequently angular. The skin is commonly grey, spotted with brown. There are individuals entirely white. The height varies from fifteen to sixteen feet. Its manners, the mode of taking it, and of treating it, have been carefully described by many travellers and naturalists, from Aristotle down to Mr Corse Scott.

---

* In A. W. Schlegel's Contributions to the History of the Elephant, in the Indische Bibliothek, i. 2, are enumerated many facts not generally known regarding the African and Asiatic Elephants, and the details are accompanied with interesting inferences.

3. ELEPHAS PRIMIGENIUS, Blum. or MAMMOTH.—*The Elephant with elongated skull, concave forehead, very long alveolæ for the tusks, the lower jaw obtuse, the grinders broader, parallel, marked with closer bands,* which we name the *Fossil Elephant (Elephas primigenius,* Blum.*),* is the *Mammoth* of the Russians. Its bones are only found in the fossil state. No person has seen in a fresh state bones resembling those by which this species is peculiarly distinguished, nor have the bones of the two preceding species been seen in the fossil state.* Its bones are found in great number in many countries, but in better preservation in the north than elsewhere. It resembles the Indian more than the African species. It differs, however, from the former in the grinders, in the form of the lower jaw, and many other bones, but especially in the length of the alveolæ and tusks. This last character must have singularly modified the figure and organisation of its proboscis, and given it a physiognomy much more different from that of the Indian species, than might have been expected from the similarity of the rest of their bones. It appears that its tusks were generally large, frequently more or less spirally arcuate, and directed outwards. There is no proof that they differ much according to differences of sex or race. The size was not much greater than that to which the Indian species may attain; it appears to have been still clumsier in its proportions. It is already manifest from its osseous remains, that it was a

---

* According to Schleiermacher, Goldfuss and Von Bachr, fossil tusks, resembling those of the African Elephant, have been found in some districts. Cuvier, however, questions their being in a true fossil state.

species differing more from the Indian, than the ass from the horse, and the jackal and isatis from the wolf and fox. It is not known what had been the size of its ears, or the colour of its skin; but it is certain that, at least, some individuals bore two sorts of hair, namely, a red, coarse, tufted wool, and stiff black hairs, which, upon the neck and along the dorsal spine, became long enough to form a sort of mane. Thus, not only is there nothing impossible in its having been able to support a climate which would destroy the Indian species, but it is even probable that it was so constituted as to prefer cold climates. Its bones are generally found in the alluvial and superficial strata of the earth, and most commonly in the deposits which fill up the bottom of valleys, or which border the beds of rivers. They scarcely ever occur by themselves, but are confusedly mingled with bones of other quadrupeds of known genera, such as rhinoceroses, oxen, antelopes, horses, and frequently with remains of marine animals, particularly conchiferous species, some of which have even been found adhering to them. The positive testimony of Pallas, Fortis, and many others, does not allow us to doubt that this latter circumstance has frequently taken place, although it is not always observed. We ourselves have at this moment under our eyes a portion of a jaw covered with millepores and small oysters.

The strata which cover the bones of elephants are not of very great thickness, and they are scarcely ever of a rocky nature. They are seldom petrified, and there are only one or two cases recorded in which they were found imbedded in a shelly or other rock. Frequently they are simply accompanied with our common fresh water shells. The resemblance, in this latter respect, as well as with regard to the nature of the soil, between the three places, of which we have the most detailed accounts, viz. *Tonna*, *Cantstadt*, and the *Forest of Bondi*, is very remarkable. Every thing, therefore, seems to announce that the cause which has buried them, is one of the most recent of those that have contributed to change the surface of the globe. It is nevertheless a physical and general cause; the bones of *fossil elephants* are so numerous, and have been found in places so desert and even uninhabitable, that we cannot suppose that they had been conducted there by man. The strata which contain them and those which are above them, shew, that this cause was aqueous, or that it was water that covered them; and in many places these waters were nearly the same as those of our present sea, since they supported animals nearly the same. But, it was not by these waters that they were transported to the places where they now are. Bones of this description have been found in almost every country that has been examined by naturalists. An irruption of the sea that might have brought them from places which the *Indian elephant* now inhabits, could not have scattered them so far, nor dispersed them so equably. Besides, the inundation which buried them has not risen above the great chains of mountains, since the strata which it has deposited, and which cover the bones, are only found in plains of little elevation. It is not, therefore, seen how the carcases of elephants could have been transported into the north, across the mountains of *Thibet*, and the *Altaic* and *Uralian* chains.

Further, these bones are not rolled; they retain their ridges and apophyses; they have not been worn by friction. Very frequently the epiphyses of those which had not yet attained their full growth, are still attached to them, although the slightest effort would suffice to detach them. The only alterations that are remarked, arise from the decomposition which they have undergone during their abode in the earth. Nor can it with more reason be represented that the entire carcases had been violently transported. In this case, the bones would indeed have remained entire; but they would also have remained together, and would not have been scattered. The shells, millepores, and other marine productions which are attached to some of these bones, prove besides that they had remained at least some time stripped and separated at the bottom of the fluid which covered them. The elephants' bones had therefore already been in the places in which they are found, when the fluid covered them. They were scattered about in the same manner as in our own country the bones of horses and other animals that inhabit it may be, and as the dead bodies are spread in the fields.

Every circumstance, therefore, renders it extremely probable, that the elephants which have furnished the fossil bones, dwelt and lived in the countries where their bones are at present found. They could only, therefore, have disappeared by a revolution, which had destroyed all the individuals then living, or by a change of climate, which prevented them from propagating. But whatever this cause may have been, it must have been sudden. The bones and ivory which are found in so perfect a state of preservation in the plains of Siberia, are only so preserved by the cold which congeals them there, or which, in general, arrests the action of the elements upon them. If this cold had come on by degrees and slowly, these bones, and still more the soft parts with which they are still sometimes invested, would have had time to decompose, like those which occur in warm and temperate countries. It would especially have been impossible that an entire carcase, like that discovered by Mr Adams, could have retained its flesh and skin without corruption, if it had not been immediately enveloped by the ice which preserved it. Thus, all the hypotheses of a gradual cooling of the earth, or of a slow variation, whether in the inclination or in the position of the axis of the globe, fall to be rejected.

If the present *elephants* of *India* were the descendants of these ancient elephants, which have been preserved in that climate to the present day, from their being there placed beyond the reach of the catastrophe which destroyed them in the others, it would be impossible to explain why their species has been destroyed in America, where remains are still found, which prove that they had formerly existed there. The vast empire of Mexico presented to them heights enough to escape from an inundation so little elevated as that which we must suppose to have taken place, and the climate there is warmer than is requisite for their temperament.

The various *mastodons*, the *hippopotamus* and the *fossil rhinoceros* lived in the same countries, and in the same districts, as the *elephants*, since their bones are found in the same strata and in the same state. Yet these animals very assuredly no longer exist. Every thing therefore, Cuvier maintains, concurs to induce a belief that the *fossil elephant* is, like them, an extinct species, although it resembles more than they one of the species at present existing, and that its extinction has been produced by a sudden cause, by the same great catastrophe which destroyed the species of the same epoch.

3. *On the Great Mastodon, or Animal of the Ohio.*

It appears that the *Great Mastodon* or *Animal of the Ohio*, was very like the elephant in its tusks and whole skeleton, the grinders excepted; that it very probably had a proboscis; that its height did not exceed that of the elephant, but that it was a little more elongated, and had limbs somewhat thicker, with a more slender belly. Notwithstanding all these points of resemblance, the peculiar structure of its grinders is sufficient to constitute it of a different genus from the elephant. It further appears, that it fed much in the same manner as the hippopotamus and boar, choosing by preference the roots and other fleshy parts of vegetables; that this sort of food must have drawn it towards the soft and marshy places; that, nevertheless, it was not formed for swimming, and living often in the water like the hippopotamus, but that it was a true land animal. Its bones are much more common in North America than any where else. They are even perhaps exclusively confined to that country. They are better preserved, and fresher, than any other fossil bones known; and, nevertheless, there is not the slightest proof, the smallest authentic testimony, calculated to impress a belief that either in America, or any where else, there is still any living individual, for the various accounts which we have from time to time read in the journals respecting living mastodons, which had been observed in the forests or plains of that vast continent, have never been confirmed, and can only pass for fables.

Note

ON THE CAVES IN WHICH BONES OF CARNIVOROUS ANIMALS OCCUR IN GREAT QUANTITIES.

The extraordinary accumulations of fossil bones in caves and caverns in different districts, especially in those composed of limestone, have for many years engaged the attention of inquirers; and, of late, have afforded many interesting facts to the geologist and zoologist. In England, as will appear from the following details, many different fossil animals have been discovered in limestone caves; but hitherto the caves in Scotland, which will probably be found to contain interesting documents of an ancient population, have not been examined. As the subject is a curious and interesting one, we shall, in the following pages, principally from Cuvier's great work, lay before our readers a pretty full account of the different caves, especially those that afford bones of carnivorous animals.

Numerous caves, brilliantly decorated with stalactites of every form, succeeding each other to a great depth in the interior of mountains, communicating together by openings so narrow as scarcely to allow a man to enter them crawling, and which are yet found strewed with an enormous quantity of bones of large and small animals, are without dispute among the most remarkable phenomena which the history of fossil remains could present to the contemplation of the geologist, especially when we reflect that this phenomenon recurs in a great number of places, and over a very extended space of country. These caves have been the object of research of several naturalists, some of whom have well described and figured the bones which they contain; and even before they were explored by the naturalist, they were celebrated among the common people, who, according to their custom, added many imaginary prodigies to the natural wonders which are really observed in them. The bones which they contain were long, under the name of *fossil unicorn*, an important article of commerce and materia medica, on account of the powerful virtues which were attributed to them; and it is probable that the desire of finding these bones contributed much to the more accurate knowledge of these caves, and even to the discovery of several of them.

The most anciently celebrated is the cave of *Bauman*, situated in the country of *Blankenburg*, which belongs to the Duke of Brunswick, to the south of the city of that name, to the east of *Elbingerode*, and to the north of the village of *Rubeland*, the nearest inhabited place, in a hill which forms one of the last declivities of the *Hartz* toward the east. It has been described by many authors, among whom we shall particularly mention the great *Leibnitz*, in his *Protogœa*, pl. i. p. 97, where he gives a map of it, borrowed from the *Acta Eruditorum* 1702, p. 305.

Its general direction is east and west, but the entrance faces the north. It is very narrow, although it is under a pretty large natural vault. The first cave is the largest. From this to the second, one must descend by another narrow passage, at first by creeping, and afterwards by a ladder. The difference of level is 30 feet. The second cave is the richest in stalactite of all forms. The passage to the third cave is at first the most difficult of all, and we have to climb with hands and feet; but it afterwards enlarges, and the stalactites of its walls are those in which the imagination of the curious has pretended to see the best characterized figures. It has two lateral dilatations, of which the map of the *Acta Eruditorum* makes the third and fourth caves. At its extremity, we have still to ascend, in order to arrive at the real third cave, which forms a sort of portal. *Behrens* says, in his *Hercynia curiosa*, that it cannot be reached, because it would be necessary to descend more than 60 feet; but the above mentioned map, and the description of *Von der Hardt*, which accompanies it, describe this third cave under the name of the Fifth, and place beyond it a narrow passage, terminated by two small grottoes. Lastly, *Silberschlag*, in his *Geogony*, adds, that one of these grottoes leads to a narrow passage, which, descending much, leads under the other caves, and terminates in a place filled with water. There are still many bones in these remote and little frequented parts. Most of those bones which are in collections from this cave, or which have been described, are of the bear genus.

A second cave, nearly as celebrated as the former, and very near, is that which is named, after the *unicorn*, *Enihornshœle*, at the foot of the chateau of *Scharzfels*, in a part of the Electorate of Hanover which is named the Dutchy of *Grubenhagen*, and nearly upon the last southern declivity of the *Hartz*. It has also been described by *Leibnitz*, as well as by *M. Deluc*, in his Letters to the Queen of England. The entrance is 10 feet high, and 7 broad. We descend vertically 15 feet into a sort of vestibule, the roof of which lowers to such a degree, that, at the end of 60 feet, we are obliged to creep. After a long passage, we come to two other caves, according to Leibnitz; but Behrens adds three or four, and says, that, according to the country people, we might penetrate nearly two leagues.

Bruckmann, who gives a map of this cavern (*Epistol. Itin.* p. 34.), represents only five caves, arranged nearly in a straight line, and connected by extremely narrow passages. The second is the richest in bones; the third, which is the most irregular, has two small lateral caves; the fifth is the smallest, and contains a fountain. Of the bones which have been taken from it, some are in the possession of M. Blumenbach and other naturalists; and others have been figured by *Leibnitz* and *Mylius*. They belong to the bear, hyena, and tiger or lion genera.

The chain of the Hartz also presents some other caves of less celebrity, although of the same nature mentioned by Behrens in his Hercynia curiosa, namely,

The cave of *Hartzburg*, under the castle of the same name, above *Goslar* to the south. We do not know why Büsching disputes its existence. It is true that Behrens cites J. D. Horstius erroneously, for having seen bones of various animals taken from it; for Horstius speaks only (*Obs. Anat. dec.* p. 10.) of the cave of *Scharzfels*.

The cave of *Ufftrungen*, in the county of *Stollberg*, to the south of the castle of that name. It is named in the country *Heim-knohle*, or *Hiding-hole*. Behrens thinks that fossil bones might be found in it.

Another cave of the same neighbourhood, is named *Diebsloch*, *Thieves' Hole*. Skulls have been found in it, which were supposed to be human.

We shall not speak here of those caves of the Hartz in which bones have not been discovered. And even those in which they have been found, are, at the present day, almost exhausted, it being only by breaking the stalactite that any can be obtained, so much of them had been taken away for selling as medicines.

The caves of *Hungary* come after those of the Hartz, with reference to the remoteness of the time at which they have been known. The first notice of them is due to *Paterson Hayn*, (Ephem. Nat. Cur. 1672, Obs. cxxxix. and cxciv.) *Bruckmann*, a physician of *Wolfenbüttel*, afterwards described them at length. (*Epistola Itineraria*, 77, and *Breslauer Sammlung*, 1725, First Trim. p. 628.) They are situated in the county of *Liptow*, on the southern declivities of the *Carpathian mountains*. They are known in the country by the name of *Dragons' Caves*, because the people of the neighbourhood attribute to those animals the bones which occur in them, and with which they have been acquainted from time immemorial; but all those which have been figured by authors belong to the Bear family, and to the species which is named the *Great Cave Bear (Grand Ours des cavernes)*.

The caves of Germany the richest in bones are those of *Franconia*, of which *J. F. Esper*, a clergyman of the country of *Bayreuth*, has given a very detailed description in a work, printed in French and German, entitled, *Description des Zoolithes nouvellement decouvertes*, &c. *Nuremberg Knorr*. 1774, folio, with 14 coloured plates), and in a memoir inserted among those of the *Berlin Society of Naturalists*, vol. ix. 1784, p. 56. Another description was afterwards given, under the title of *Objets dignes de remarque des environs de Muggendorf*, by J. C. Rosenmüller, folio, with coloured views, Berlin, 1804. And more lately, M. Goldfuss, at present Professor of Natural History at Bonn, and Secretary of the *Academia Naturæ Curiosorum*, has made them the subject of a particular work printed in 1810 in German, under the title of *Environs of Muggendorf*, in which he describes them with the greatest care, as well as the surrounding country, of which he gives a very correct topographical chart. A great part of these caves is situated in a small bailiwick, named *Streitberg*, which was formerly a dependence upon the country of *Bayreuth*, but was inclosed in that of *Bamberg*, and now forms part of the kingdom of Bavaria. The greatest number occur in a small peninsula, formed by the river of *Wiesent*, which falls into the Pegnetz, and belongs to the basin of the *Main*.

However, the chief of all these astonishing caves, those of *Gaylenreuth*, are beyond the limits of this peninsula, being on the left bank of the Wiesent, to the north-west of the village from which it derives its name. The entrance is perforated in a vertical rock; it is 7½ feet high, and faces the east. The first cave turns to the right, and is upwards of 80 feet long. The unequal heights of the vault divide it into four parts; the first three are from 15 to 20 feet high, the fourth is only 4 or 5. At the bottom of this latter, on the level of the floor, there is a hole 2 feet high, which affords a passage to the second cave: it has first a direction to the south, over a length of 60 feet by

40 in breadth, and 18 in height; it then turns to the west for 70 feet, becoming lower and lower until at length the height is only 5 feet. The passage which leads to the third cave is very inconvenient, and one has to turn through various corridores: it is 30 feet across, and from 5 to 6 in height. The ground in it is kneaded with teeth and jaws. Near the entrance is a pit of from 15 to 20 feet, to which one descends by a ladder. After having descended, we come to a vault of 15 feet diameter by 30 in height; and towards the side at which the descent is made there is a cave strewed with bones. On still descending a little, a new arcade is met with, which leads to a cave 40 feet long, and a new pit of from 18 to 20 feet deep. After descending this, we reach a cavern about 40 feet high, all strewed with bones. A passage, of 5 feet by 7, leads to a grotto of 25 feet in length by 12 in breadth. Canals, 20 feet in length, conduct to another grotto of 20 feet in height. Lastly, there is another cave, 83 feet broad and 24 high, in which more bones are found than in any of the others.

The sixth cave, which is the last, has a northerly direction, so that the whole series of caves and passages nearly describes a semicircle.

A fissure in the third cave led to the discovery, in 1784, of a new cave, 15 feet long and 4 broad, in which the greatest quantities of hyena and lions' bones were found. The aperture was much too small for these animals to have passed through it. A particular canal which ended in this small cave has afforded an incredible number of bones and large skulls entire.

In the Philosophical Transactions of 1822, pl. xxvi. there may be seen a profile of this cave, taken on the spot in 1816, by Professor Buckland, in which is to be especially remarked an enormous mass, entirely composed of bones enveloped in the stalactite, and thus forming an osseous breccia, but of quite a different nature from those which occur at Gibraltar and other places [*].

The cave of *Gaylenreuth* is one of those the bones of which are most completely known, by the researches which have been made or caused to be made in it for a long time back by distinguished naturalists, such as MM. Esper, de Humboldt, Ebel of Bremen, Rosenmüller, Sœmmering, Goldfuss, &c., and by the numerous and rich collections which these researches have produced. According to the examination which Cuvier has made of the principal of these collections, three-fourths of the bones found there belong to the Bear genus, and to two or three species of that genus. The others belong to the hyena, tiger, wolf, fox, glutton, and polecat, or some nearly allied species. There are also found, although in much smaller number, bones of herbivorous quadrupeds, and, in particular, deer, of which fragments are in the possession of M. Ebel. It would even appear from a passage of M. Sœmmering's, that a parcel of bones had been got in it belonging to an elephant's skull [†]. According to Rosenmüller, there were found in it bones of men, horses, oxen, sheep, deer, roes, mules, badgers, dogs, and foxes, but which from the researches made by him in the cave itself, and from their state of preservation, must have been deposited at periods much later than those of the bear, tigers and hyenas [*].

---

[*] This plate forms the frontispiece to the present work.

[†] Sœmmering uber die fossilien Knocken, welche in der *Protogæa* Von Leibnitz abgebildet sind: eine Abhandlung in der Magazin fur die Naturgeschichte des Menschen von C. Grosse, iii. 1790, s. 73.

The small peninsula situate nearly opposite to this cave, presents several other caves, as the *Schœnstein*, or *Beautiful Rock*, which contains seven contiguous caverns. The *Brunnenstein*, or *Fountain Rock*, in which, according to Esper, there are only found bones of known species, such as badgers, dogs, foxes, hogs, and deer; but Esper had too little anatomical knowledge for his testimony to be entirely relied on with respect to this. These bones are sometimes encrusted with stalactite. It contains also the *Holeberg*, or *Hollow Mountain*, in which eight or ten caves form a series of 200 feet in length, with two entrances. Bones of the same bears as at *Gaylenreuth*, are found here in various lateral depressions; and there are also deer and hogs.—The *Wizerloch*, so named from an ancient Sclavonic deity formerly worshipped there, the most dismal cavern of the whole country, situate in its most elevated part, and in which some vertebræ have been found. It is more than 200 feet long.—The *Wunderhœhle*, which takes its name from its discoverer, has been known since 1773: its extent is 160 feet.—Lastly, the Cave of *Klaustein*, consisting of four grottoes, and upwards of 200 feet deep. Bones have been found in the third grotto, and most abundantly towards its extremity. It might be supposed that the name *Klaustein* signified *Claw-rock*, and it would thus accord very well with a place where, without doubt, as at Gaylenreuth, a multitude of ungual phalanges of bears and animals of the tiger kind have been found. But M. Goldfuss asserts, that it was called *Klaustein*, or *St Nicholas's Rock*, after a chapel of this name, which formerly stood upon it.—There are still the *Geiss-knok*, or *Goat Cave*, and a cave discovered in 1798. M. Rosenmüller found in them two human skeletons already covered with stalactite.

---

[*] Rosenmuller, Beschreib. des Hohlenbaren, s. 2.

The country which surrounds this small peninsula has itself several caves, independently of that of *Gaylenreuth*, as those of *Mockas*, *Rabenstein*, and *Kirch-ahorn*, three villages, situate, the first to the south, and the other two to the north-east of Gaylenreuth. Bones were formerly found in the first. The last bears in the country the expressive name of *Zahn-loch*, or *Tooth Cave;* it also bears the name of *Hohen-mirschfeld*, a village on whose ground it is situate; and the country people have long been in the habit of seeking in it those bones, which they imagined to be medicinal. MM. Rosenmüller and Goldfuss have in fact found bear and tiger bones. There are two others in the territory of the same village, of which the one named *Schneider-loch* (*Tailor's Hole*), is said to have furnished the vertebræ of an elephant. That of *Zewig*, close upon *Waschenfeld*, at the very edge of the *Wiesent*, is nearly 80 feet deep; and it is said that skeletons of men and wolves were found in it.

All these hills, containing caves in their interior, and situate so near each other, seem to form a small chain, interrupted only by brooks, and which joins the more elevated chain of the *Fichtelberg*, in which are the highest mountains of Franconia, and from which flow the *Main*, the *Saale*, the *Eger*, the *Naab*, and many small rivers. M. Rosenmüller, and after him, others assert, that those which are in the hills to the north of the *Wiesent*, contain not a single fragment of bone, while those to the south are filled with them.

In 1799, a cave, remarkable for its situation, was discovered, which connects in some measure those of the *Hartz* with those of *Franconia*. It is the Cave of *Glücksbrun*, in the bailiwick of *Altenstein*, in the territory of *Meinungen*, on the south-western declivity of the chain of the *Thuringerwald* (Blumenb. *Archæol. Telluris*, p. 15. *Zach. Monatc. Corresp.* 1800, *January*, p. 30.) It is the same which M. Rosenmüller names *Libenstein*, on account of its being on the road from *Altenstein* to this latter, which is a bathing place. There is a description of it by M. Kocher, in the *Magazin fur Mineralogie*, by M. C. E. A. De Hof, 1st band. heft. iv. p. 427. The limestone in which it is situate rests upon bituminous schist, and, rising much upwards, comes to rest upon primitive rocks. The limestone varies in hardness and in the nature of its fracture, and contains marine petrifactions, such as pectinites, echinites, &c.

In making a road, there was discovered an opening, from which a very cold air issued, which determined the Duke of Saxe-Meinungen to have it farther examined. A narrow passage, of twenty feet in length, was found, which led to a cave of thirty-five feet, having a breadth of from three to twelve, and a height of from six to twelve, according to the places, and terminated by a large piece of rock, which was removed. The labour of two years discovered and cleared a series of caves connected together, and of which the bottom rose and fell alternately. They terminate in a place where water flows; but various lateral fissures make it probable that there are still several caves which have not been opened, and that they perhaps form a sort of labyrinth.

The bottom and walls of this cave are furnished with the same mud as the others, but blacker. The bones were pretty numerous, and tinged with the same colour, but only two tolerably entire skulls were obtained. That of which M. Kocher gives a figure, is the species of bear named *Ursus spelæus*. There are also caves of this kind in Westphalia. J. Es Silberschlag, in the *Mem. des Naturalistes* of Berlin (*Schriften*, vol. vi. p. 132), describes the one called *Kluter-hœhle*, near the village of *Oldenforde*, in the county of *Mark*, on the edge of the *Milspe* and *Ennepe*, two streams which fall into the Ruhr, and with it into the Rhine. Its entrance is about half-way up a hill called *Kluterberg*, is only three feet three inches high, and faces the south. The cave itself forms a true labyrinth in the interior of the mountain.

Not far from this, in the same county, at Sundwich, two leagues from *Iserlohn*, is another cave, which, for about twenty-five years back, has furnished a very large quantity of bones, part of which has been carried to Berlin, and the rest has remained in the country in the hands of various individuals *.

If we cast a glance upon a general map, it is not difficult to perceive a certain continuity in the mountains in which these singular caves occur. The Carpathians join with the mountains of Moravia and those of Bohemia called *Bœhmerwald*, to separate the basin of the Danube, from those of the Vistula, Oder and Elbe. The Fichtelgebirge separates the basin of the Elbe from that of the Rhine. The Thuringerwald and the Hartz continue to limit the basin of the Elbe, by separating it from that of the Weser.

---

* Further information in regard to these caves will be found in Leonhard Taschenb. der Min. vii. 2. S. 439; and in Nöggerath's Gebirge in Rheinland-Westphalen, ii. S. 27. and iii. 1. 13.

These different chains have but slight intervals between them. The caves of Westphalia alone are not connected in so evident a manner with the others.

Very lately, bones have been discovered in a cavern, which extends more towards the south, and is even situate on the other or Italian side of the Alps. It is that of *Adelsberg* in *Carniola*, a place situate on the great road from *Laybach* to *Trieste*, and about half way between these two cities. The whole of this country is full of caverns and grottoes, which have given rise to numerous sinkings of the surface, thus giving a very singular appearance to the country. Several of these caverns have long been celebrated among naturalists. That of *Adelsberg* is generally visited by travellers, on account of its being near the highway, and because a river called the *Piuka* or *Poike* is lost there, forming a subterranean lake, and emerging again on the north side, under the name of *Unz*. A hole which the Chevalier de *Lowengreif* discovered in 1816, in one of its walls, at the height of 14 fathoms, conducted him to a series of new caves of vast extent, and of incomparable beauty, from the lustre and variety of their stalactites.

A part of these caves was, however, known, and must be, or have been accessible, by some other place, for inscriptions were found in them with dates, from 1393 to 1676, together with human bones, and entire carcases, that had been buried there. A German pamphlet was published at Trieste, in which are described all the windings of these subterranean passages, their different halls, their domes, their columns, and all the other appearances produced by their stalactites. We shall not follow the author (M. de *Volpi*, Director of the School of Commerce and Navigation at Trieste) through this immense labyrinth. Let it suffice to say, that this zealous naturalist asserts his having proceeded more than three leagues, almost in a straight line, and that he was only stopped by a lake which rendered it impossible to go on. It was about two leagues from the entrance that he discovered bones of animals, of which he gives figures, and which he describes under the name of Palæotheria. He had the politeness to communicate to me, says Cuvier, his drawings the year before, but it appears my reply did not reach him, for he makes no mention of it in his book.

Be this as it may, his figures clearly shewed that the bones in question belonged to the great cave-bear. In fact, several of these bones having been presented to the Congress of Laybach, *Prince Metternich*, whose enlightened taste for the advancement of knowledge has already been of so much service, had the goodness to address them to Cuvier, who disposed them in the Royal Cabinet, where any one may satisfy himself as to their species.

There are, without doubt, caves in many other chains, and several are known in France. Caves occur in Suabia, but no bones have been found in them; and, in general, it appears, that, before the last discoveries, and especially that which has been made in Yorkshire, none were known but those of Germany and Hungary that were rich in bones of carnivora. In truth, the rock of *Fouvent*, and which contains in one of its cavities bones of hyenas, and at the same time those of elephants, rhinoceroses and horses, might be considered as belonging to this order of phenomena; but as it was not explored to any depth, it cannot be certain that it is so.

The case is different with the *Kirkdale* Cavern. It having been visited immediately after its discovery by several well informed persons, and especially by Mr Buckland, every thing has been made known with respect to it. It is situated in the East Riding of the county of York, twenty-five miles NNE. of the city of *York*, and at about the same distance to the west from the sea and the town of Scarborough. The small river of *Hodgebeck* is lost under ground in the neighbourhood, much in the same way as the *Piuka* near *Adelsberg*. It is placed in one of the limestone hills which form the northern boundary of the vale of *Pickering*, the waters of which fall into the Derwent. Mr Buckland compares the stone to that of the last strata of the Alpine limestone, such as are seen near Aigle and Meillene.

It was in the course of the year 1821, that some labourers working at a quarry, discovered by chance the opening, which was closed by rubbish, covered over with earth and turf. It is about 100 feet above the neighbouring brook. It can be entered to the distance of 150 or 200 feet, but we can only walk erect in some places, on account of the stalactites. On its sides there are seen spines of sea-urchins and other marine remains, incrusted in the mass of the rock; but it is on the bottom, and there only, that there is found the stratum of mud, of about a foot thick, stuck full of bones, as at Gaybeneath. This mud, and the bones which it contains, are, in various places, covered or penetrated with stalactite, especially near places where the rock has lateral fissures.

The discovery having acquired much celebrity, a great number of people procured bones from it, and placed them in various public depots. Specimens have been deposited in the York Institution, that of Whitby and Bristol, the British Museum, the Museum of Oxford and Cambridge, and by Mr Young of Whitby, in the College Museum of Edinburgh; but the finest collection of the bones of Kirkdale was presented to Cuvier, and by him deposited in the Royal Cabinet in Paris. The greatest number of these bones without comparison, belong to hyenas of the same species as those of the caverns of Germany; but there are also many of other large and small animals, which Mr Buckland supposes to form twenty-one species. From the pieces which I have under my eye, says Cuvier, there indisputably occur bones of the *elephant*, *hippopotamus*, *horse*, an *ox* of the size of the common *deer*, *rabbits*, *field-rats*; also bones of some other carnivora, namely, of the *tiger*, *wolf*, *fox*, and *weasel*. All these bones and teeth are accumulated on the ground, broken and gnawed, and there are even seen marks of the teeth which have fractured them. There are even intermixed with them excrements which have been recognized as perfectly similar to those of the hyena *.

---

* In England and Wales the following caves have been found to contain fossil bones:

1. Cave in *Duncombe Park*, not far from that of Kirkdale. It contains only recent bones.

2. Cave of *Hutton*, a village in Somersetshire, at the foot of the

The hills in which these caverns occur resemble each other in their composition : they are all of limestone, and

---

Mendip Hills. Bones of elephants, horses, hogs, of two species of deer, of oxen, the nearly entire skeleton of a fox, and the metacarpal bone of a large bear, have been found in it.

3. Cave of *Derdham Down*, near to *Clifton*, to the westward of Bristol. Bones of horses were found in it.

4. Cave of *Balleye*, near to *Warksworth*, in Derbyshire. In 1663, teeth of elephants, some of which are still preserved, were found in it.

5. Cave of *Dream*, at the village of *Callow*, near to *Warksworth*. It was discovered in the year 1822, by some miners in search of lead-ore. Nearly all the bones of a rhinoceros, in a good state of preservation, were found enclosed in a bed of mud in this cave.

6. Fissures and caves at *Oreston*. These are in transition limestone. Bones of the rhinoceros, hyæna, tiger, wolf, deer, ox, and horse, have been found in them.

7. Cave of *Nicholaston*, near the coast of *Glamorgan*, in the Bay of *Oxwich*. In the year 1792, bones of the elephant, rhinoceros, ox, deer, and hyæna, were found in it.

8. Caves of *Paveland*, in the county of *Glamorgan*, between the Bay of Oxwich and Cape Worms, at the entrance of the English Channel. There are two openings in a cliff thirty or forty feet above the level of the sea, which we cannot reach but at low water. The clergyman and the surgeon of the neighbouring village of Portinan found in them a tusk and grinder of an elephant; afterwards other bones of the elephant, rhinoceros, horse, bear, hyæna, fox, wolf, ox, deer, rat, of birds, the *skeleton of a woman*, and splinters of bones, were also found. But many of these bones are modern; and the diggings made at remote and unknown periods have displaced the ancient bones, and mixed them with the modern, and also with shells of the present sea.

Professor Goldfuss, in the 11th volume of the *Nova Acta Physico-medica Academiæ Cæsareæ Leopoldino-Carolinæ Naturæ Curiosorum*, published in 1823, gives an account of the fossil bones he met with in the caves of Westphalia and Franconia. Speaking of the Cave of Gaylenreuth, he says, that Esper has the following remarks on the quantity of bones taken from these caves :

all produce abundance of stalactites. These stalactites line the walls, narrow the passages, and assume a thou-

---

On first examination, there were collected, in a very short time, in the dust of the floors of these caves, upwards of 200 different teeth; and we may assume that, by the end of the year 1774, some thousands were collected. It is difficult to form a conception of the number of these zoolithes, and of the earth in which they are contained; and I do not hesitate in believing, that, at the lowest estimate, several hundred waggons load would not remove the whole. The animal earth, with intermingled bones, was, in many places, eight or ten feet deep. Esper calculated that, in his time, 180 skulls had been taken out of the loose animal earth, the conglomerate not having been broken up for this purpose. Of late years, the conglomerate afforded, in the space of three years, 150 skulls; and we may estimate that twice as many more were destroyed in breaking them out of the hard stalactitic matter. If we add to this the pieces of skulls which occur in this repository, more frequently than perfect skulls, we may estimate that more than a thousand individuals lie buried here.

These bones occur now, as formerly, irregularly dispersed; that is, teeth, cylindrical bones, cranial bones, and vertebræ of different species, and of different individuals of different ages, and of various sizes, occur conglutinated together. We never find the under jaw of the same skull near to it, and rarely the two separated portions of the same lower jaw together; the skulls occurring all in the deeper places: and Esper found the teeth forming a bed by themselves. The bones still possess their sharper edges, and are neither rubbed nor gnawed.

If we assume a thousand buried individuals, the proportion of the different species will be, according to Dr Goldfuss, as follows:

1. Hyæna spelæa,	- -	25
2. Canis spelæus,	- -	50
3. Felis spelæa,	- -	25
4. Gulo spelæus,	- -	30
5. Ursus priscus,	- -	10
6. Ursus arctoideus,	- -	60
7. Ursus spelæus,	- -	800

sand various forms. The bones are nearly in the same state in all these caverns: detached, scattered, partly broken, but never rolled, and consequently not brought from a distance by water; a little lighter and less solid than recent bones, but still in their true animal nature, very little decomposed, containing much gelatine, and not at all petrified. A hardened, but still easily frangible or pulverisable earth, also containing animal parts, and sometimes blackish, forms their natural envelope. It is

---

The bones of small animals, mentioned by Esper, are now no longer met with; and, in the collections of Esper and Frischmann, Dr Goldfuss saw only a few dozen of the glutton (Gulo.) The contents of a peculiar conglomerate described by Esper, cannot now be determined. It consisted of a confused assemblage of very small bones, the fracture surfaces of which were fibrous, and contained also the thigh-bone and rib of a bird, which were conjectured to equal in size those of the eagle; hence Esper inferred that the mass was made up of the remains of reptile and fish bones.

No remains have hitherto been found in these caves; but in former times we are told that teeth of the elephant were found in the Zahnloch, and a vertebra, supposed of a rhinoceros, in the Schneiderloch. The bones of domestic animals, such as deer, roes, foxes, and badgers, frequently found in the caves, shew, at a glance, that they have come into their present situation accidentally, at a modern period.

The cave at *Mockas* formerly contained in its deepest fissures, teeth and fragments of bones of bears, associated with rolled stones, and enveloped in earthy marl. The entrance to this cave is situated on the acclivity of a hill. Goldfuss ascended to the entrance of it by means of a rope, and found in its interior many narrow, wide extended hollows, which are generally so confined that we can only visit them by creeping. Here and there there are small widenings, and frequently narrow outlets occur in the roof.

The *Zahnloch* and the *Schneiderloch*, which also contain single bones of bears, are small vaults, with wide openings, into which we can penetrate without difficulty.

often impregnated and covered with a crust of stalactite. A covering of the same nature invests the bones in various places, penetrates their natural cavities, and sometimes attaches them to the walls of the cavern. This stalactite is often coloured reddish by the animal earth which is mixed with it. At other times its surface is stained black; but it is easy to see that these appearances are caused by modern occurrences, and have no immediate connection with the cause which brought the bones into these cavities. We even daily see the stalactite increasing and enveloping here and there groups of bones which it had formerly respected.

This mass of earth, penetrated by animal matter, indiscriminately envelopes the bones of all the species; and, if we except some found at the surface of the ground, and which had been transported there at much later periods, which may also be distinguished by their being much less decomposed, they must all have been interred in the same manner, and by the same causes. In this mass of earth there are found, confusedly mingled with the bones (at least in the cave of Gaylenreuth), pieces of a bluish marble, of which all the corners are rounded and blunted, and which appear to have been rolled. They singularly resemble those which form part of the osseous breccix of *Gibraltar* and *Dalmatia*.

Lastly, what further conspires to render this phenomenon very striking, is, that the most remarkable of these bones are the same in these caverns, over an extent of more than two hundred leagues. Three-fourths and upwards belong to species of *bears*, which are now extinct. A half, or two-thirds of the remaining fourth, belong to a species of *hyena*, which is equally unknown at the present day. A smaller number belong to a species of the *tiger* or *lion* kind, and to another of the *wolf* or *dog* genus; lastly, the most diminutive have belonged to various small carnivora, as the *fox*, the *polecat*, or at least species very nearly allied to them, &c.

The Kirkdale Cavern, however, forms a notable exception, inasmuch as none, or very few, bones of bears are found in it, and in its being the hyena that appears to predominate among the carnivora.

The species so common in the alluvial formations, the *elephants*, *rhinoceroses*, *horses*, *oxen* or *aurochs*, and *tapirs*, are of very rare occurrence in the caves of Germany. There are even some in which no one is said to have found them, and the only bones of herbivora mentioned are remains of deer. In this point also, however, the Kirkdale cave differs much from the others, inasmuch as it abounds almost as much in bones of large and small herbivora, as in bones of carnivora. All the great pachydermata of the alluvial formations are seen in it: the elephants, rhinoceroses and hippopotami. There are also seen in it bones of oxen, deer, and even small bones of mice and birds. But there are no bones of marine animals of any species, either at Kirkdale or in Germany. Those who have pretended that they saw bones of *seals*, *morses*, or other similar species, have been led into error by the hypothesis which they had previously adopted.

These bones of carnivora, so numerous in the caves, are rare in the great alluvial strata; the hyena alone has been seen in any quantity at Canstadt, near Aichstedt, and in some other places. There have also been found some traces of bears in Tuscany and Austria, but their relative proportion is always infinitely less than in the caves; and it is always sufficiently proved by these circumstances, that these various animals have lived together in the same countries, and have belonged to the same epoch.

Cuvier concludes, there can only be imagined three general causes which might have placed these bones in such quantity in these vast subterranean cavities. Either they are the remains of animals which inhabited these abodes, and which died peaceably there; or inundations and other violent causes have carried them into these cavities; or, lastly, they had been enveloped in rocky strata, the dissolution of which produced these caverns, and they have not been dissolved by the agent which carried off the matter of the strata.

This last cause is refuted by the fact, that the strata in which the caves occur contain no bones; and the second by the entireness of the smallest prominences of the bones, which does not permit us to think that they had been rolled; for if some bones are worn, as Mr Buckland has remarked, they are only so on one side, which would only prove that some current has passed over them, and in the deposit in which they are. We are, therefore, obliged to have recourse to the first supposition, whatever difficulties it presents on its part, and to say that these caves served as a retreat to carnivorous animals, and that these carried there, for the purpose of devouring them, the animals which formed their prey, or the parts of these animals.

Mr Buckland has observed, that the hyena bones are not less broken and splintered than those of the herbivorous animals; from which he concludes, that the hyenas had devoured the dead bodies of their own species, as those of the present day still do.

These animals attack each other during their life; for the fossil head of a hyena is preserved, which had evidently been wounded and afterwards healed [*].

---

[*] The fact mentioned in the text brings to our recollection an interesting Memoir of Professor Walther, entitled, "On the Antiquity of diseases in Bones," printed in Grasse and Walther's Journal der Chirurgie und Augenheil Kunde, viii. From eleven specimens of bones of cave-bears found in the Caves of Sundwich, described by Walther, a proof is obtained, that the common forms of osseous diseases occur in them, just as they are observed at present in the human species, viz. necrosis, anchylosis, caries, exostosis, formation of new bony matter, thickening, thinning, and arthritic properties of diseased bones. Most of those diseases are such as would result from violent injuries, and the consequent very tedious organo-vital reaction. Such mechanical injuries would give rise to necrosis, caries, exostosis, &c. We can easily conceive, says Walther, how that the rapacious animals of a former world may have been exposed to violent mechanical injuries of their bodies and of single parts of them. It is worthy of remark, that most of the diseased bones are of the lower jaw, the alveolar processes of it and the walls of single alveolæ. During the combats of the cave bears for their prey amongst themselves, or with other gigantic animals, the jaws and teeth must have experienced the greatest mechanical injuries. The necroses of the humeral bones are such as might result from a bruising of the bones, and the caries of the upper surface of the bodies of the lumbar vertebræ, may have been occasioned by external violence. Walther is also of opinion, that the cave-bears suffered from diseases of the bones not referrible to mechanical injuries. He remarks of a radius and a vertebra, whose arthritic condition he carefully describes, "These bones have experienced pathological changes, which could only arise from a long continued diseased condition of the nutritive process. They are very light, have an extremely thin crust, the greater part of their mass is of a spongy, very porous substance, and are uncommonly fragile.

This supposition is moreover confirmed by the animal nature of the earth in which these bones are found *.

This much is certain, that the establishment of these animals in the caves has taken place at a much later epoch than that at which the great rocky strata have been formed, not only those which compose the mountains in which the caves are situated, but the strata of much newer origin. No permanent inundation has penetrated into the subterranean dens, and formed a regular rocky deposit. The mud arising from the proper decomposition of these animals, and the stalactites that have been filtered through the wall of the caves, are the only matters which cover these remains, and these stalactites increase so rapidly, that M. Goldfuss already found a layer

---

Such a change could not be produced by any external mechanical injury, nor by any slight action of the weather; but must proceed from a tedious constitutional disease, connected with a total change of the organo-forming plastic activity, and proceeding from a peculiar dyscrasia." Hence it is probable, these cave-bears even suffered from gout, scrophula, and other similar diseases.

* According to Laugier, in 100 parts of the earth in which the bones in the caves of Gaylenreuth are imbedded, he found the following proportional quantity of constituent parts;

1. Lime, with a little magnesia, in the state of carbonate,	32.0
2. Carbonic acid and moisture, - - - -	24.0
3. Phosphate of lime, - - - - - -	21.5
4. Animal matter and water, - - - - -	10.0
5. Alumina slightly coloured with manganese, - -	4.0
6. Silica coloured with iron, - - - - - -	4.0
7. Oxide of iron, probably combined with phosphoric acid,	3.5
8. Loss, - - - - - -	1.0
	100.0

of them covering the names of MM. Esper and Rosenmuller, whose visits did not date thirty years before his own. The rolled stones that are met with, and the marks of detrition observed on some bones, announce, at the very utmost, but passing currents.

But how have so many ferocious animals which peopled our forests been extirpated? All the reply we can make is, that they must have been destroyed at the same time, and by the same cause, as the large herbivora, which, like them, also peopled these forests, and of which no traces remain at the present day any more than of them.

ACCOUNT OF THE CAVE CONTAINING BONES AT ADELSBERG IN CARNIOLA.

The following interesting account of the cave, slightly noticed at pages 524 and 525, is extracted from a memoir by M. Bertrand Geslin, Member of the Natural History Society of Paris, published in the number of the *Annales des Sciences Naturelles* for April 1826.

M. Cuvier, says Gesler, speaking of the Adelsberg Cave, from the account published by M. Volpi of Trieste, says, that it was nearly two leagues from the entrance where he discovered bones of animals.

Having visited this cave myself, I am obliged to say that M. Volpi's assertion as to this matter is not very correct. On my way to Trieste, in July 1823, before going to Adelsberg, I had the advantage of seeing M. Volpi. In shewing me the bones collected by him at

Adelsberg, he also assured me that they were found two leagues from the entrance of the cave, and only in a very compact block of several cubic feet, from which it was not possible to procure more, as he had taken all that he could easily remove.

Notwithstanding this discouraging account, I betook myself to Adelsberg, in order to see a sample of those immense caverns of secondary limestone. The entrance of the cave is situated in a white compact secondary limestone, lying in great beds inclined to the south-west, at an angle of from 30 to 35 degrees. At fifty paces from the entrance, we find ourselves as in a large apartment, which crosses the torent of the Pinka. After passing to the left bank of this torrent, we enter a rather low and not long passage, which leads to a second apartment of an elongated form. It is here that the line of chambers truly commences. They are of large but variable dimensions, and are situated nearly upon a horizontal plane.

On entering this second chamber, I saw that the ground was formed of a yellow and reddish clayey mud, from one to two feet thick, and more or less impregnated and covered with crusts of yellow stalagmites. In the places where it offered little resistance, I dug it up with the point of my hammer, and was fortunate enough to disunite some fragments of bone, although, from what had been said to me, I ought not to have expected to find them. From this I was convinced, that if M. Volpi had only found bones at a distance of two leagues from the entrance, it was because he had not been at the trouble to search for them nearer. I fell to work with more ardour, and succeeded in digging up some in good preservation, such as radii, cubiti, femora, humeri, fragments of jaws, calcarea, toes, vertebræ, &c., belonging to bears of different sizes, of the species termed *Ursus spelæus*. It would appear that the hyena tribe is rather rare here, for I only procured a single bone belonging to it. It was particularly in two small lateral chambers, near the narrow passage, that I obtained a great quantity of these bones, the clay there having been dug up by the guides, in order to make the floor of the great apartment even with it.

I continued to dig as I advanced, and everywhere found bones more or less broken and enveloped in the clayey mud. After proceeding for half an hour, I fell in with a mass, in an apartment of considerable dimensions, which was of a conical form, and composed of blocks of compact white limestone, of all sizes, mixed with yellowish clayey mud. These blocks had their edges as sharp as if they had only been lately broken. The mass, which reached to the right wall of the cave, might be fifteen feet in height, and twenty in diameter at its base: it was covered with stalactite in several places. It was in this mass, at about ten feet above the floor of the cave, in the clayey mud that filled up the interstices between the blocks, that I found the entire skeleton of a young bear, in a space of two square feet at most. The bones which I dug out were the frontal part of the head, the lower jaw of the left side, the seventh cervical and eighth dorsal vertebræ; the eighth and fourteenth ribs of the right side; two tibia, femora, and cubiti, and two large canine teeth of another bear. If I could have raised up the limestone blocks, between which these bones lay, I might without doubt have procured a great part of this skeleton. There are still found here and there in the cave some small heaps of clayey mud, with fragments of white secondary limestone, as well as large isolated limestone blocks, which the guides are daily destroying, to make the floor even for the convenience of visitors.

I had only advanced an hour and a quarter's progress into the cave, always finding bones, when the oil of my lamps beginning to fail, I was obliged to return without reaching the block in which M. Volpi had found the first bones. This block is without doubt owing to the same causes as the heap of which I have spoken above.

The manner in which these heaps exist, being composed of blocks of compact white secondary limestone, similar to that which forms the walls of the cave, with sharp edges, and piled upon each other, made me imagine that they might have fallen from the roof. As I returned, I examined the ceiling of the vaults with attention. As it was all covered over with stalactites, I could not discover any fissure.

From this short excursion in the Adelsberg cave, I am induced to believe, that the bones exist along the whole extent of the cave, and that they occur in two different ways; 1*st*, scattered in the clayey mud which forms the floor of the chambers; and, 2*dly*, buried in heaps formed of blocks of white secondary compact limestone, and yellow clayey mud.

The hypothesis which M. Cuvier admits as the most probable for explaining the presence of these bones in the caves, is that which would make these caves to have served as a retreat to carnivorous animals.

The presence of bones in the clayey mud of the floor of the Adelsberg cave accords well with this hypothesis; but the case is different with those which I found in the heaps of limestone blocks and clayey mud. The bones are not at the surface of the heap, but rather towards its middle part, buried among the blocks, and crushed by them. From this position, and the height at which the skeleton mentioned above occurs from the floor of the cave, it cannot be supposed that it formed part of the bones with which the bottom of the cave is strewed, nor that the blocks had fallen upon it. The bones contained in the heap in question must have been brought into their present position at the same time, and by the same cause as the limestone blocks. They could not, therefore, have belonged to animals which inhabited these caves, and died there peaceably.

If it be remarked, that these blocks, which are sometimes very large, heaped up above one another, and mixed with clayey mud, have their angles perfectly fresh, and are of the same nature as the limestone of the walls of the cave, it cannot be admitted that they have been brought from a distance. This mode of arrangement could only have been produced by their falling from the roof of the cave.

The following facts also give support to this opinion, In the cave of Gaylenreuth, a fissure of the third grotto, was the means, in 1784, of disclosing a new one, fifteen feet long and four broad, where the greatest quantity of hyena or lion bones were found. *The aperture was much too small for these animals to have passed through it.*

In a cave discovered in 1824, in the district of Lanark in Upper Canada, Mr Bigsby observed, that the floor was covered with debris of brown granular limestone, similar to that of the walls, and that the bones especially formed a heap there. He thinks that the animal, whose bones have been found in this cave, was much too large to have got into it alive or entire.—*Silliman's Journal, June* 1825, p. 354.

It must therefore be also admitted here, either that the bones could only have got into the cave in the same manner as the heaps of blocks found in the Adelsberg cave; that is to say, by falling from the roof, or that the apertures have been closed since the period at which the animals were buried.

If it be now considered, 1*st*, That the surface of the secondary limestone mountains of Carniola is covered with a layer of reddish clay; and, 2*dly*, That the clayey mud of the heap in the Adelsberg cave is mineralogically the same as that which forms the floor of the cave; may it not be supposed, that the same catastrophe which produced the heaps in the cave may have, at the same time, introduced into it the reddish clayey mud of the surface, which, by extending itself over the floor of the cave, would have contributed to cover the bones that were lying there?

Moreover, may it not have been the case, that, after the caves had been inhabited by the carnivorous animals, the substances falling from above, and coming from the surface of the soil, may have carried along with the clayey mud and the bones of bears, the spoils of large herbivorous animals, which they may have met with, and which cannot be supposed to have sought refuge in these caves during life.

There will, no doubt, be objected to me, that opinion which maintains, that the bones of herbivora have been dragged into the caves by the carnivorous animals. This might certainly have been the case with regard to small species, but it is not probable that the bones of large species could have been introduced in the same manner.

Admitting as certain, at least with regard to the Adelsberg cave, that the limestone blocks and the bear bones which accompany them, have fallen from the ceiling, the phenomenon of caves containing bones would connect itself pretty well with that of osseous brecciæ in a geological point of view. As M. Cuvier observes, "The nature of the rocks which contains the one and the other is not very different; and, besides, the fissures of caves being generally pretty wide, the bones would not have stuck, but would have fallen to the bottom, while those of the osseous brecciæ being much narrower, and not so deep, would have retained the bones at no great distance from the surface of the soil.

Thus, from the facts observed in the caves of Germany and England, and from that of the Adelsberg cave, which I have described above, we may conclude, 1*st*, That the presence of bones in caves has been produced at two different periods, which, without doubt, have not been very distant from each other; the first, that when the animals inhabited these caves; the other, that when they had been transported there by a somewhat general catastrophe; *2dly*, That the second epoch was contemporaneous with the osseous brecciæ, and was produced, like them, by a phenomenon or process of filling up.

TABULAR VIEW

OF

GENERA of FOSSIL MAMMIFERA, CETACEA, AVES, REP-
IA, and INSECTA,—exhibiting their Geognostical Number
l Distribution.

S OF GENERA.	Genera which are found: Living only.	Living, and in the Fossil State.	Fossil only.	In the Strata anterior to the Chalk.	In the Strata of the Chalk.	In the Strata posterior to the Chalk.	Number of Species: In the Living State.	In the Fossil State.	OBSERVATIONS.
MMIFERA.									
,- - - -		*				*		4	
ela, - - -		*				*		2	
- - - - -		*				*		4	
a, - - -		*				*		1	
- - - -		*				*		2	
, - - - -		*				*		2	
phis, - - -		*				*		2	
, - - - -		*				*		1	
ola, - - -		*				*		2	
nys, - - -		*				*		2	
, - - - -		*				*		2	
lonyx, - -			*			*		1	
therium, -		*	*			*		1	
as, - - -		*				*			
don, - -			*			*		6	
potamus, -		*				*		4	
- - - -		*				*		1	
otherium,			*			*		2	
don, - -			*			*		1	
bunus, - -			*			*		3	
acotherium,			*			*		2	
s, - - -			*			*		1	
potamus, -			*			*		1	
ceros, - -		*				*		4	
therium, -			*			*		8	
odon, - -			*			*		5	

TABLE—*continued.*

NAMES OF GENERA.	Genera which are found						Number of Species.		OBSERVATIONS.
	In a Living State only.	Living and Fossil.	In a Fossil State only.	In the Strata anterior to the Chalk.	In the Strata of the Chalk.	In the Strata posterior to the Chalk.	In the Living State.	In the Fossil State.	
MAMMIFERA.									
Tapirus, - - -		•				•		**1**	
Elasmotherium, -			•			•		**1**	
Equus, - - - -		•				•		**1**	
Mus, - - - -		•				•		**1**	
Cervus, - - -		•				•		**5**	
Bos, - - - -		•				•		**4**	
Myoxus, - - -		•				•		**2**	
		•							
CETACEA.									
Manatus, - - -		•				•		**1**	**It is extremely difficult to make out the genera of the Birds,** whose remains occur in a fossil state, and there are more of them than those mentioned.
Delphinus, - -		•				•		**4**	
Balæna, - - -		•				•		**3**	
AVES.									
Sturnus, - - -		•				•		1	
Pelecanus, - -		•				•		1	
Charadrius, - -						•		1	
REPTILIA.									
Testudo, - - -		•				•		6	
Crocodilus, - -		•			•			6	
Plesiosaurus, - -			•					1	
Ichthyosaurus, -			•	•				4	
Pterodactylus, -			•	•		•		3	
Rana, - - - -		•				•		1	
Mosasaurus, - -			•					1	
Salamandra, - -		•			•	•		1	

TABLE—*continued.*

	Genera which are found						Number of Species		
F GENERA.	In a living state only.	Living and Fossil.	In a Fossil state only.	In the Strata anterior to the Chalk.	In the Strata of the Chalk.	In the Strata posterior to the Chalk.	In the living state.	In the fossil state.	OBSERVATIONS.
ECTA.									
, - -		*				*			In the lignite; the number of species cannot be given in the insects.
lio, - -		*				•			In amber.
o, - -		*				•			Do.
,- - -		*				•			Do.
,- - -		*				•			Do.
, - -		*				•			Do.
a, - -		*				•			Do.
mon, -		*				•			Do.
ula, - -		*				•			In the fissil rocks, according to the old authors.
seus, -		*				*			Do.
endra, -		*				*			Do.
, - -		*				*			Do.
robia, -		*				*			Do.
s, - -		*				*			Do.

TABULAR VIEW

OF

The Classes, Orders, or Families, of Animals, occurrin
Living and Fossil State, with their Geognostical Distributi

Names of Classes, Orders, or Families.	Number of Genera which are found						Total number of Genera.	Number of Species		Observat
	In the living state only.	Living and Fossil.	In the Fossil state only.	In the Strata anterior to the Chalk.	In the Strata of the Chalk.	In the Strata posterior to the Chalk.		In the living state.	In the fossil state.	
Polyparia, - -	23	30	52	47	19	36	105	527	414	
Stellaridæ, -		4			2	4	4	76	4	
Echinidæ, - -	2	6	3	7	8	5	11	95	112	
Annulosa, - -		2	1	1	1	2	3	17	29	
Serpulacea, -	2	3	1	3	3	3	6	36	69	
Cirripeda, - -	8	2		1		2	10	50	17	
Tubicolæ, - -	1	3	2			5	6	11	16	
Pholadaria, -		2				2	2	12	4	
Bivalve shells,	18	61	24	44	25	51	103	1009	1104	
Univalve shells,	33	87	28	27	16	93	148	1945	1544	
Genera little known, - -			4	3	1		4		5	
Crustacea, - -		21	5	5	2	9	28		54	
Pisces, - - -		54	6	11	2	55	60		183	
Mammifera & Cetacea, - -		24	12			36	36		89	
Aves, - - -		3				3	3		3	The fossil re of birds bein difficult to cognised, the ber of gene that state i doubtedly n more conside
Reptilia, - -		4	4	3	2	4	8		23	
Insecta, - -		14				14	14			
Vegetabilia, -		14	10	12	1	15	24			

THE END.

BOOKS

INTED FOR WILLIAM BLACKWOOD, EDINBURGH;
AND T. CADELL, STRAND, LONDON.

Elegantly Printed, in 3 vols. royal octavo,

EXOTIC FLORA;

Containing
FIGURES AND DESCRIPTIONS
OF
W, RARE, OR OTHERWISE INTERESTING EXOTIC PLANTS,
Especially of such as are deserving of being Cultivated in our Gardens;
TOGETHER WITH
EMARKS UPON THEIR GENERIC AND SPECIFIC CHARAC-
ERS, NATURAL ORDERS, HISTORY, CULTURE, TIME OF FLOWERING, &c.

By WILLIAM JACKSON HOOKER, LL.D. &c.

ber of the Imperial Academy Naturæ Curiosorum; of the Wernerian Natural History Society of
Edinburgh; of the Royal Botanic Society of Ratisbon; of the Helvetic Society of Natural
History, &c. &c. and
Regius Professor of Botany in the University of Glasgow.

he Work includes, under the title of EXOTIC FLORA, Figures and De-
tions of such Plants, not natives of Great Britain, as are Cultivated in our
lens, or, in defect of them, of such as can be faithfully represented from
-preserved specimens in our Herbaria. In the selection of Species, prefer-
is, of course, given to such as recommend themselves by their beauty,
history, novelty, or some remarkable or little-known characters in their
rs and fruit.

In one large volume 8vo, with Eight Plates, price 15s.

EMENTS OF THE PHILOSOPHY OF PLANTS;

aining the Principles of Scientific Botany, Nomenclature, Theory of Clas-
sification, Phytography, Anatomy, Chemistry, Physiology, Geography, and
Diseases of Plants; with a History of the Science, and Practical Illustra-
tions.

By A. P. DECANDOLLE, and K. SPRENGELL.

Translated from the German.

In octavo, price 15s.

FLORA EDINENSIS;

OR
DESCRIPTION OF PLANTS GROWING NEAR EDINBURGH,
nged according to the Linnean System; with a Concise Introduction to
the Natural Orders of the Class Cryptogamia, and Illustrative Plates.

By ROBERT KAYE GREVILLE, F.R.S. & F.A.S. E.

Member of the Wernerian Natural History Society of Edinburgh, &c. &c. &c.

A New Edition, entirely re-composed, in 4 large vols. 8vo. L.3.

A SYSTEM OF CHEMISTRY.

By THOMAS THOMSON, M.D. F.R.S. &c. &c.

In one vol. 8vo. with Four Maps of the Constellations, and a Plate of the figu illustrative of the Work. The Second Edition, corrected and improv Price 9s.

AN ELEMENTARY TREATISE ON ASTRONOMY;

Or, an Easy Introduction to a Knowledge of the Heavens,

Intended for the Use of those who are not much conversant in Mathematica Studies.

By the Rev. A. MYLNE, D. D.

Minister of Dollar, Honorary Member of the Royal Physical Society, and Fellow of the Society of Scottish Antiquaries.

Handsomely Printed in 8vo. the Second Edition, Price 14s. of

WERNER'S NOMENCLATURE OF COLOURS,

With Additions, so as to render it highly useful to the Arts and Sciences, part cularly Zoology, Botany, Chemistry, Mineralogy, and Morbid Anatomy. A nexed to which are examples selected from well-known objects in the A mal, Vegetable, and Mineral Kingdoms.

By PATRICK SYME,

Flower-Painter, Edinburgh; Painter to the Wernerian and Caledonian Hor cultural Societies.

"Having the good fortune to possess a colour-suite of minerals, made, und the eye of Werner, by my late friend H. Meuder of Freyberg, and being de rous of making this collection as generally useful as possible, I mentioned wish to Mr Syme, who readily undertook to make a delineation of all the var ties in this collection. This he executed with his usual skill and accuracy; ad ing, at the same time, to the series several other colours, which he has disti guished by appropriate names, and arranged along with those in the Werneri system. The whole has been published in a series of Tables, in a Treatise whi ought to be in the hands of every Mineralogist, and indeed in the possession Naturalists of every description."—Professor Jameson's *Characters of Minera*

In One Volume large 8vo. Price 14s.

HISTORICAL SKETCH

OF

THE PROGRESS OF DISCOVERY, NAVIGATION, AND COMMERCE,

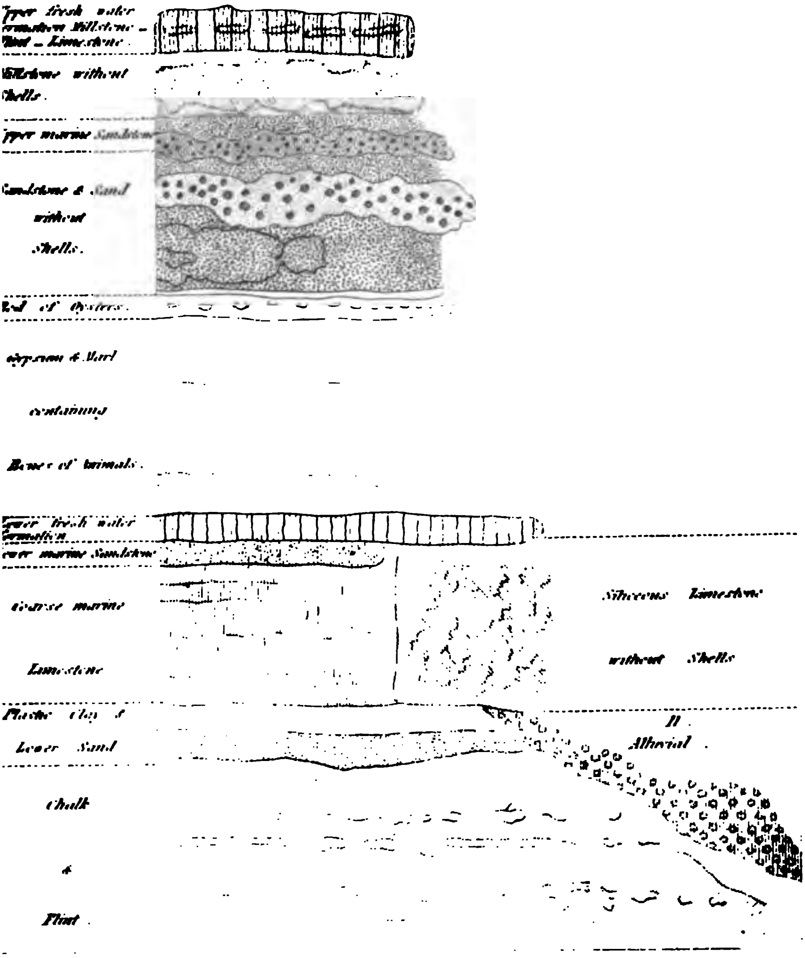
From the earliest Records to the beginning of the Nineteenth Century.

By WILLIAM STEVENSON, Esq.

⁂ This Historical Sketch has been drawn up with reference to, and i order to form the 18th and concluding Volume of Kerr's Voyages and Tr vels. But though drawn up with this object, it is strictly and entirely an i dependent and separate Work. At the conclusion of the Volume is given a S lect Catalogue of Voyages and Travels, which, it is hoped, will be found gen rally useful, not only in directing reading and inquiry, but also in the formati of a Library.

PLATE I.

PLAN
Shewing the relative position of the
MINERAL FORMATIONS
around
PARIS

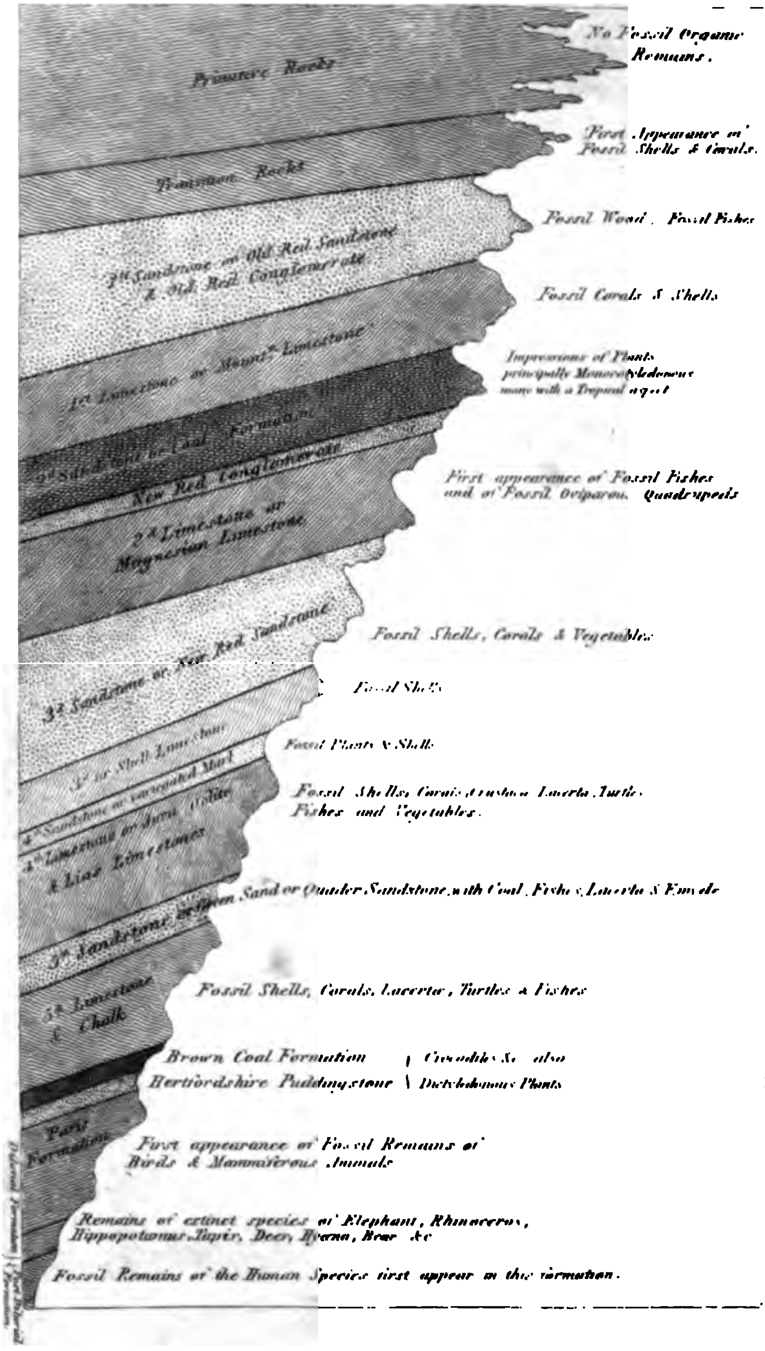

Upper fresh water formation Millstone – Flint – Limestone.
Millstone without Shells.
Upper marine Sandstone
Sandstone & Sand without Shells.
Bed of Oysters.
Gypsum & Marl containing Bones of Animals.
Lower fresh water formation
Lower marine Sandstone
Coarse marine Limestone
Siliceous Limestone without Shells
Plastic Clay & Lower Sand
H. Alluvial.
Chalk & Flint.

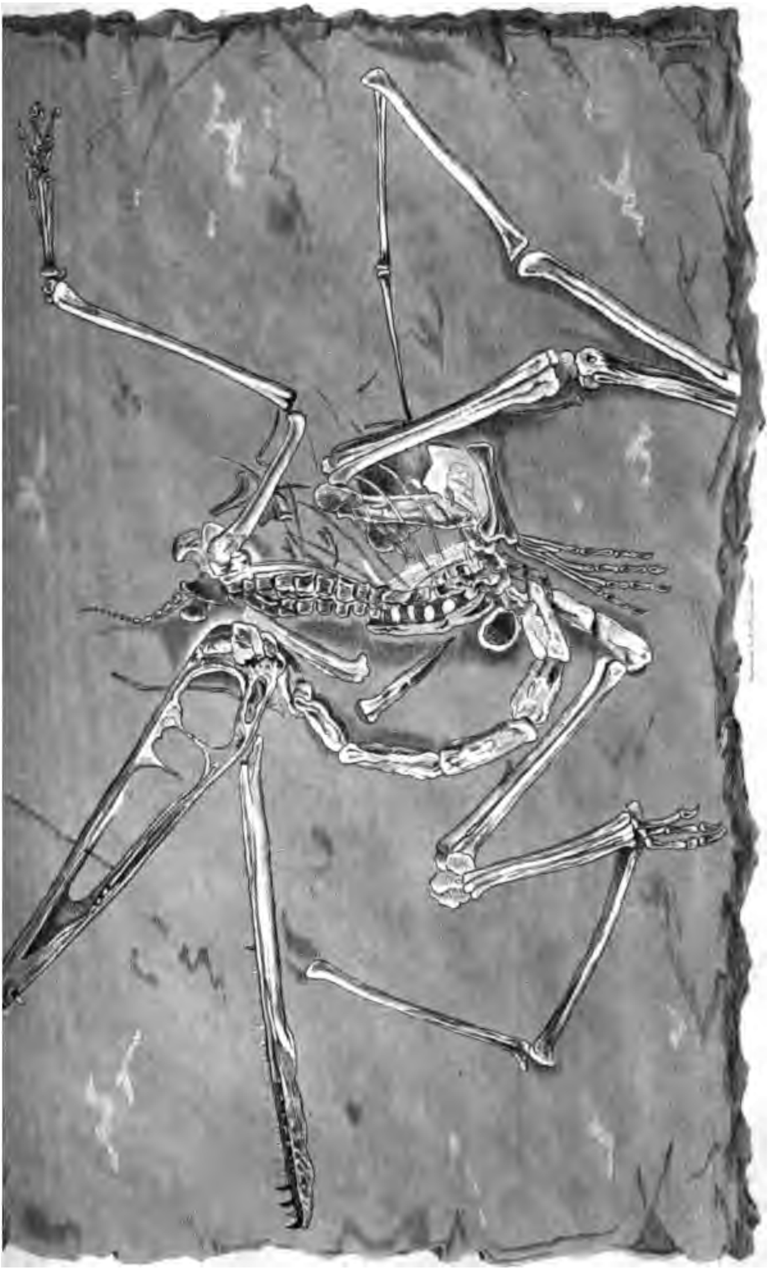
W. & D. Lizars Sc. Edin.r

Edinburgh, Published by W. Blackwood 1827.

PLATE II.

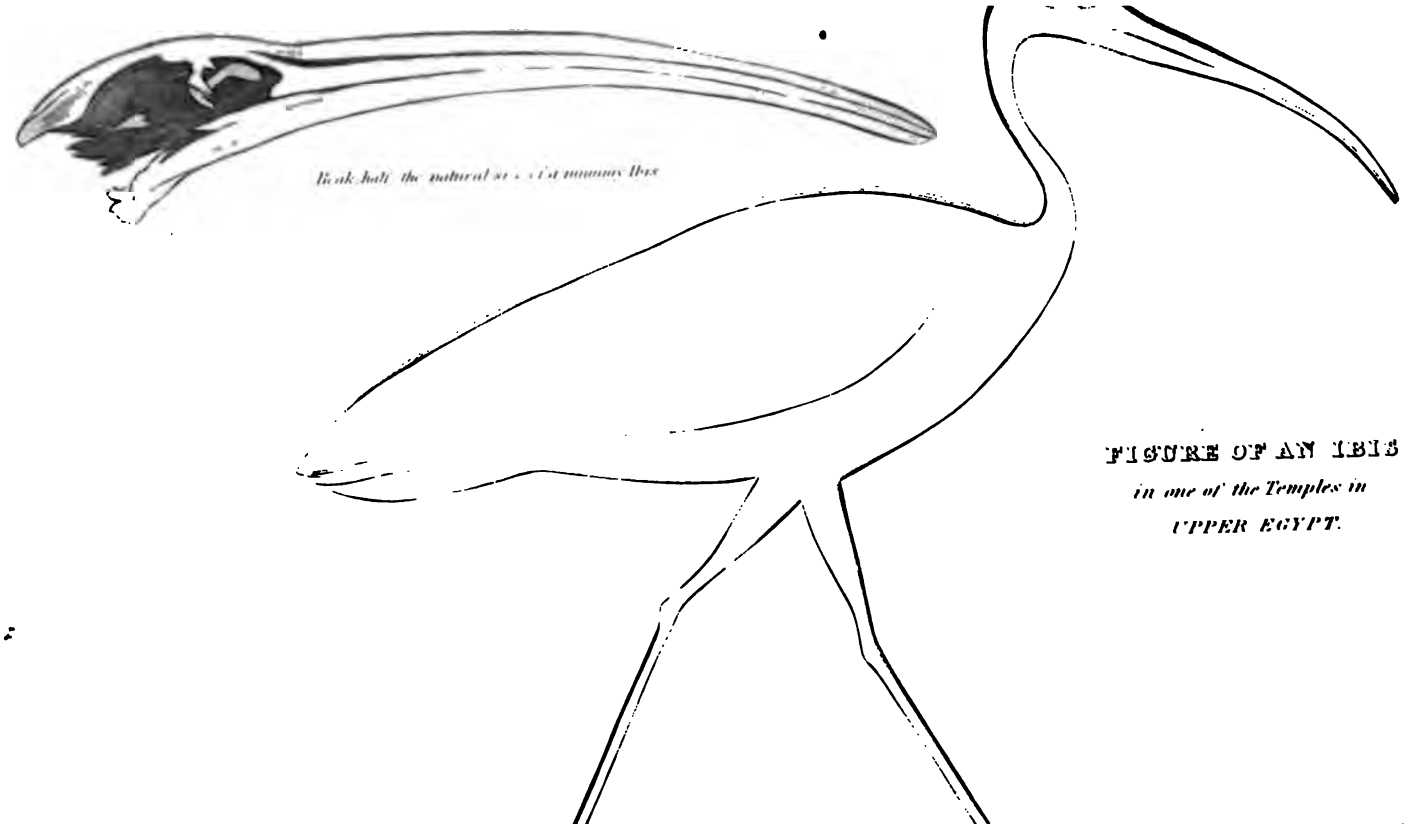
Page 448


SECTION
No Fossil Organic Remains.
Primary Rocks
First Appearance of Fossil Shells & Corals.
Transition Rocks
Fossil Wood. Fossil Fishes
1st Sandstone or Old Red Sandstone & Old Red Conglomerate
Fossil Corals & Shells
1st Limestone or Mount^n Limestone
Impressions of Plants principally Monocotyledonous more with a Tropical aspect
2d Sandstone or Coal Formation
New Red Conglomerate
First appearance of Fossil Fishes and of Fossil Oviparous Quadrupeds
2d Limestone or Magnesian Limestone
Fossil Shells, Corals & Vegetables
3d Sandstone or New Red Sandstone
Fossil Shells
3d or Shell Limestone
Fossil Plants & Shells
4th Sandstone or variegated Marl
Fossil Shells, Corals, Crustacea, Lacerta, Turtles, Fishes and Vegetables.
4th Limestone or Jura Oolite & Lias Limestones
5th Sandstone or Green Sand or Quader Sandstone, with Coal, Fishes, Lacerta & Emyde
Fossil Shells, Corals, Lacertæ, Turtles & Fishes
5th Limestone & Chalk
Brown Coal Formation
Hertfordshire Puddingstone
Crocodiles &c. also Dicotyledonous Plants
Paris Formation
First appearance of Fossil Remains of Birds & Mammiferous Animals
Remains of extinct species of Elephant, Rhinoceros, Hippopotamus, Tapir, Deer, Hyena, Bear &c
Diluvial Formation
Fossil Remains of the Human Species first appear in this formation.
Post Diluvial Formation.



Extraordinary animal, named **PTERODACTYLUS LONGIROSTRIS** found near Aichstedt in Germany.

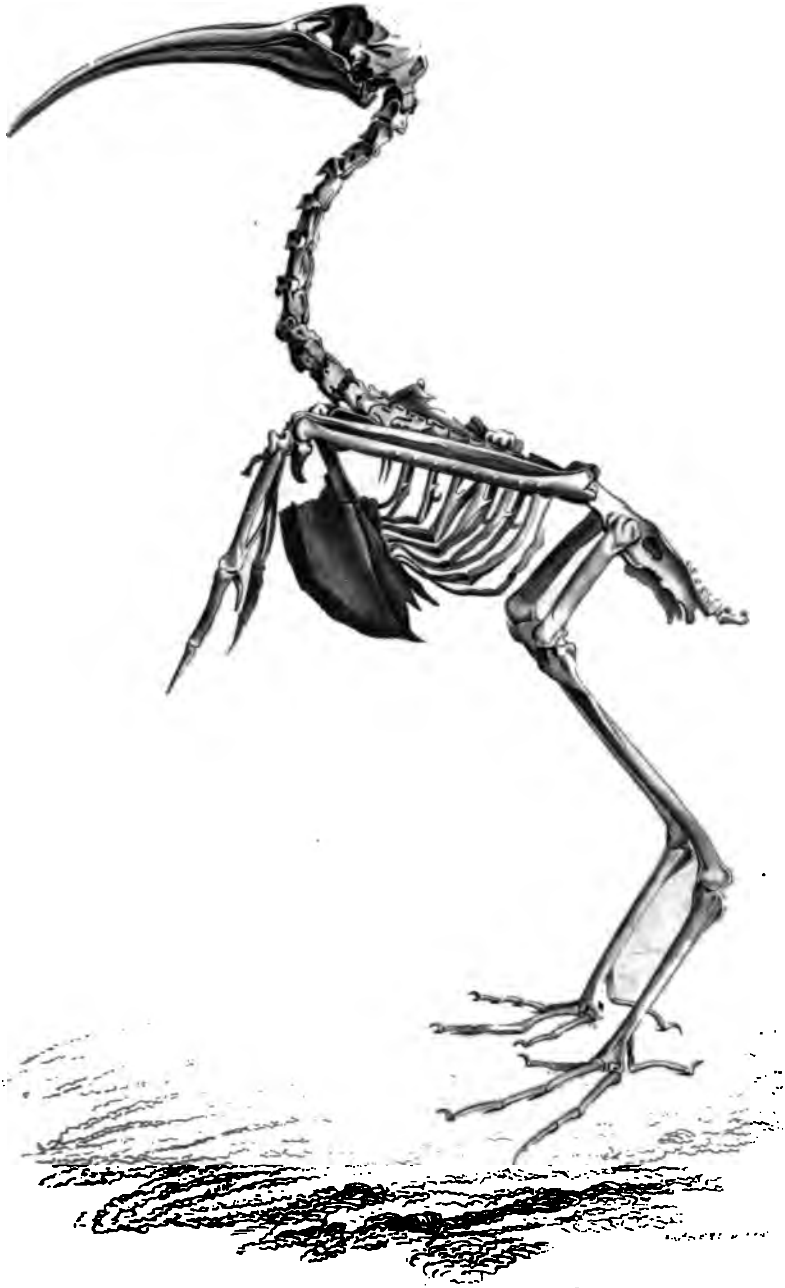
Edinburgh Published by W.m Blackwood 1817



Beak half the natural size of a mummy Ibis

FIGURE OF AN IBIS
in one of the Temples in
UPPER EGYPT.

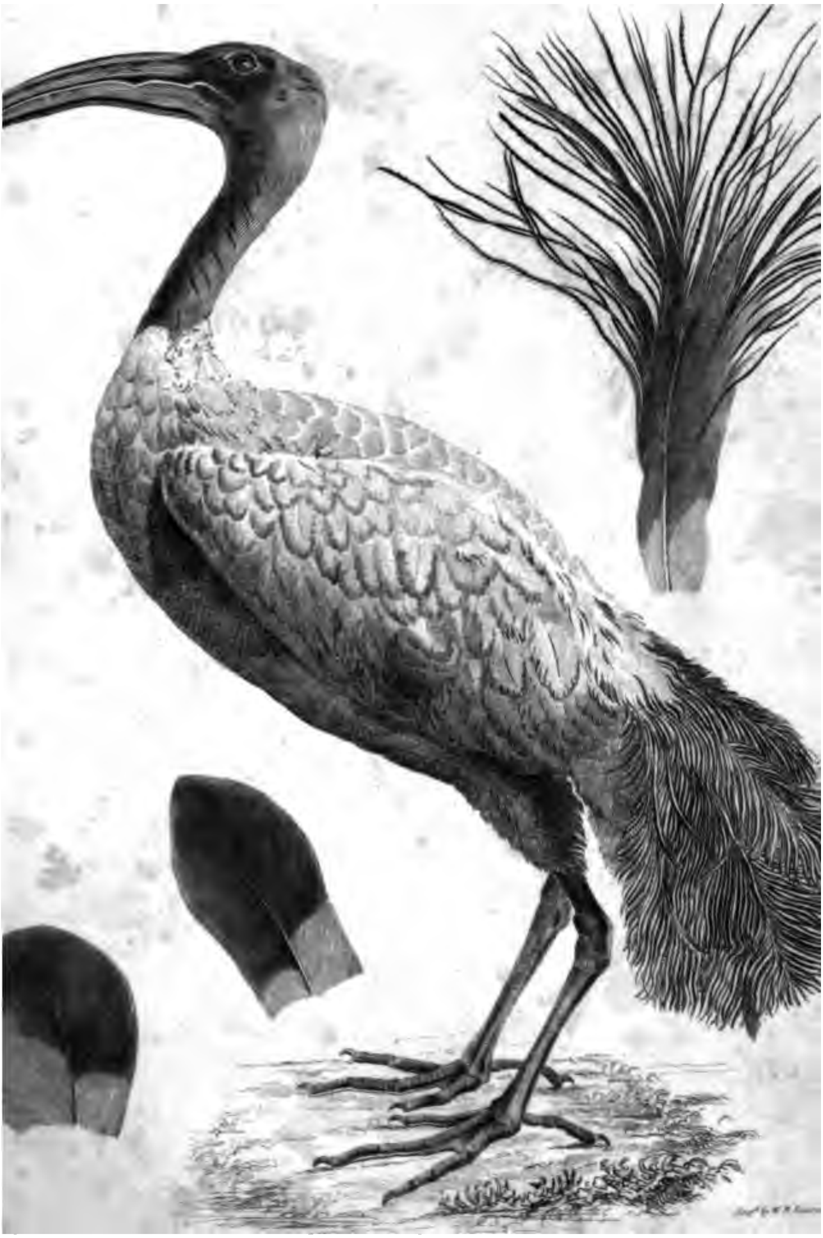
PLATE IV.



SKELETON OF AN IBIS
extracted from a Mummy found at

PLATE V.

Page .



NUMENIUS IBIX

Supposed to be the true Ibix of the

EGYPTIANS.

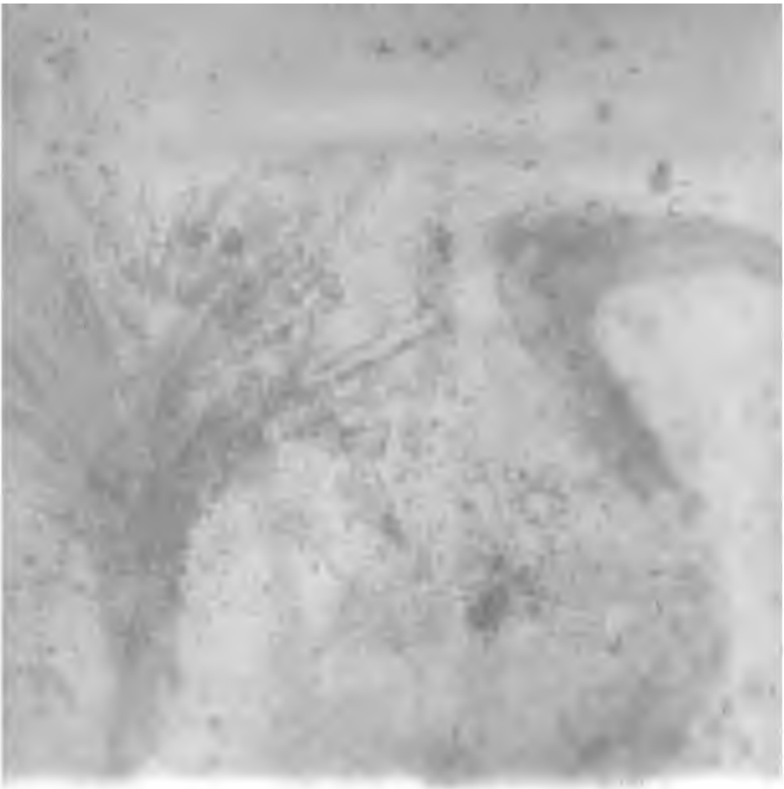
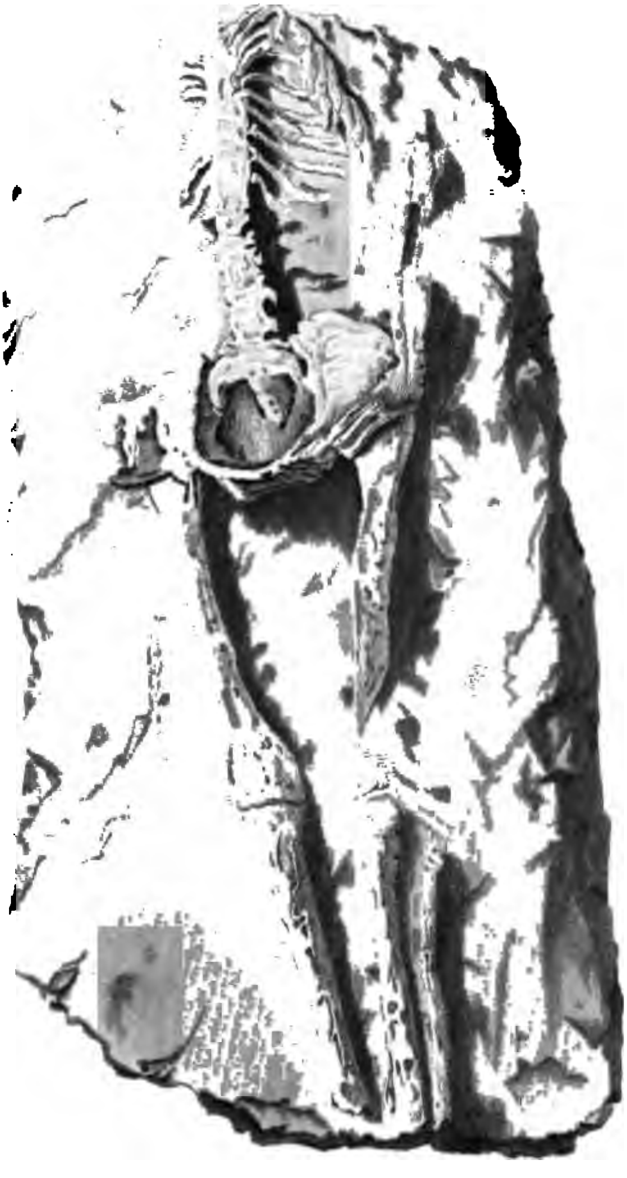


PLATE 17.

Page 401.

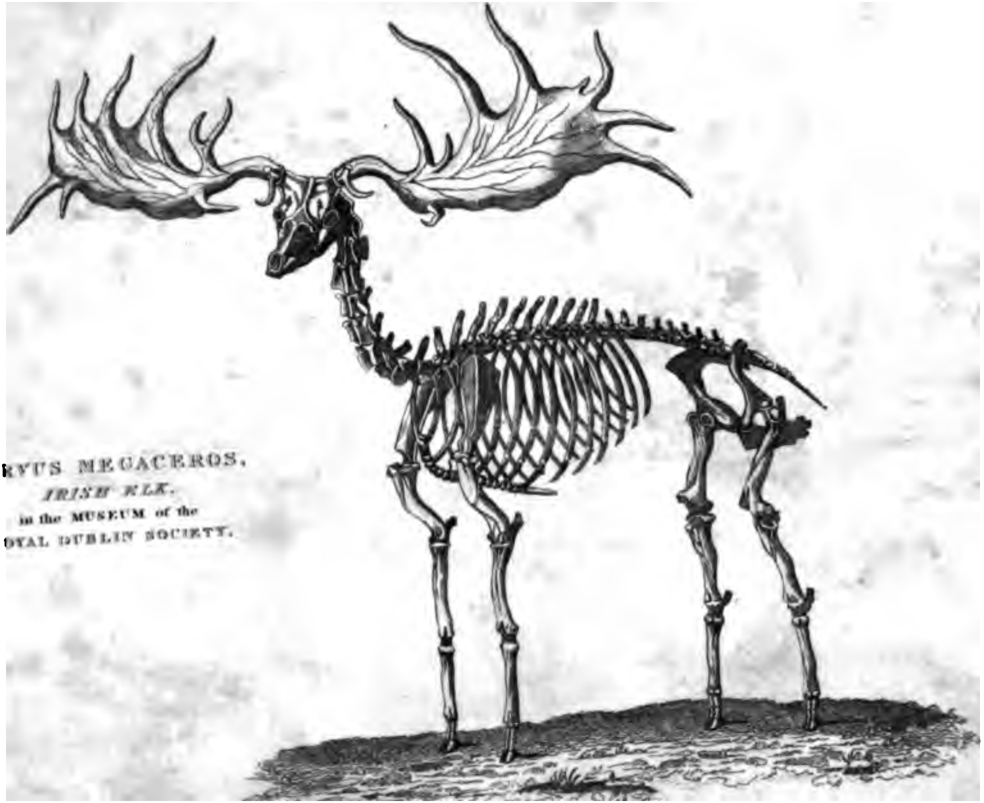


FOSSIL

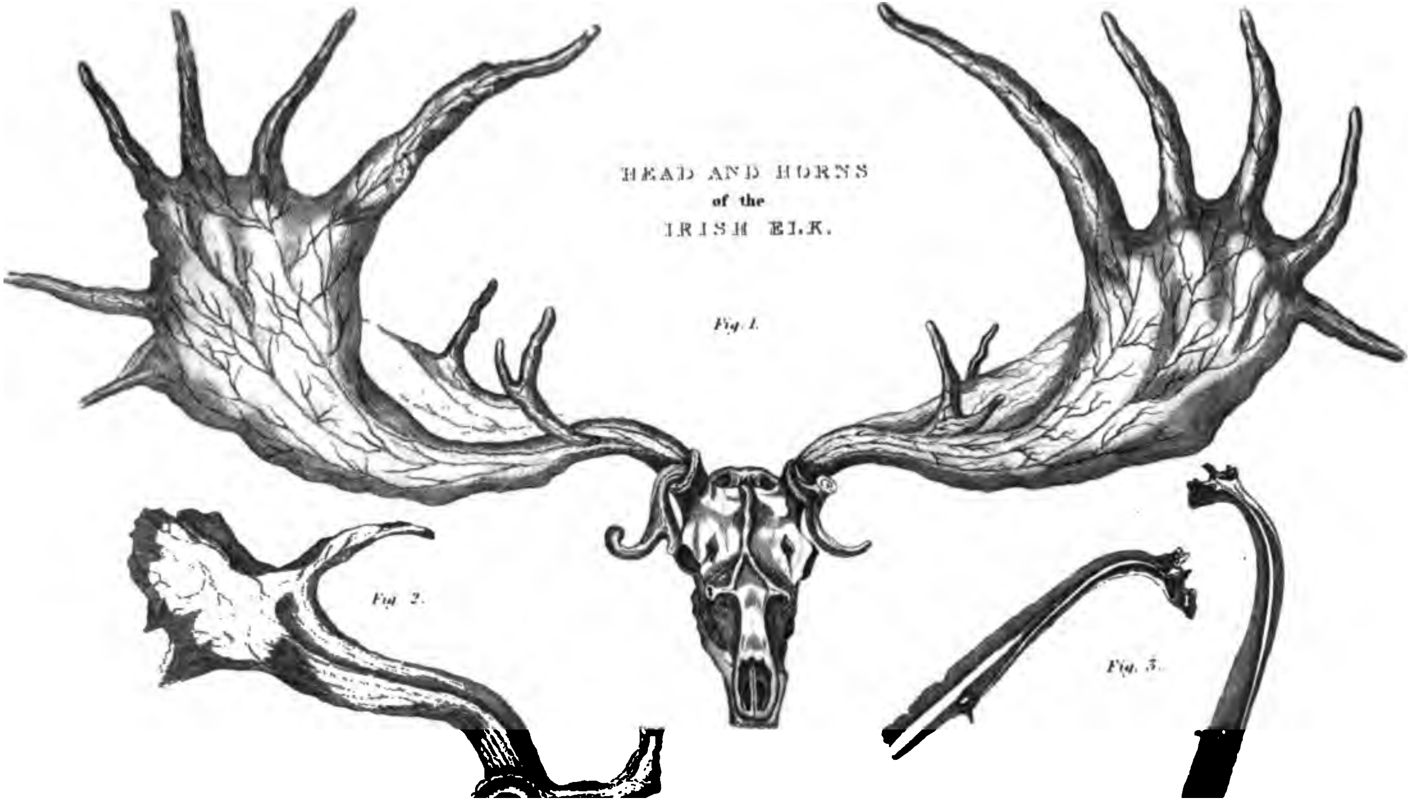
HUMAN SKELETON,

FOUND IN GUADALOUPE

[illegible] 1827.



CERVUS MEGACEROS,
IRISH ELK,
in the MUSEUM of the
ROYAL DUBLIN SOCIETY.

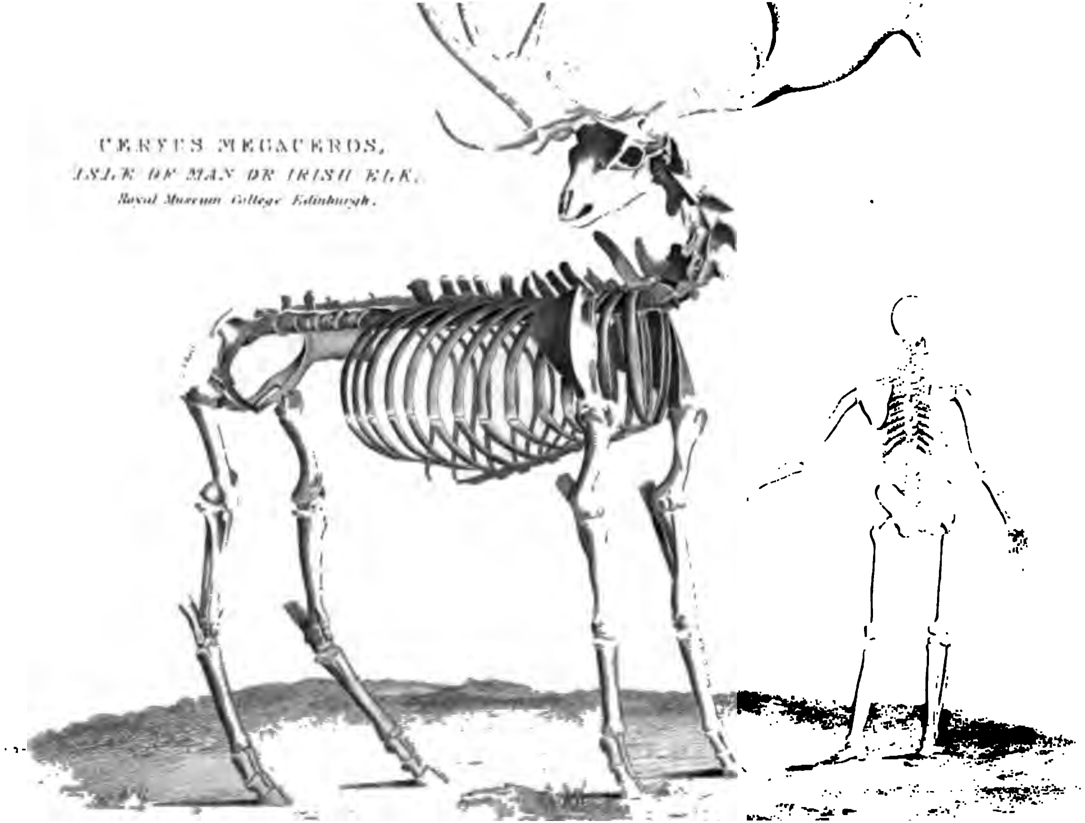


HEAD AND HORNS
of the
IRISH ELK.

Fig. 1.

Fig. 2.

Fig. 3.



CERVUS MEGACEROS,

ISLE OF MAN OR IRISH ELK.

Royal Museum College Edinburgh.

550 .C992
Essay on the theory of the ear C.1
Stanford University Libraries
3 6105 032 199 072

BRANNER
GEOL. LIB.
Locked
stack

Stanford University Libr
Stanford, California

Return this book on or before dat

MAY 4 - 1988
JUN